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Earth's rotary motion *at the equator* exceeds 1000 miles an hour; but the velocity of rotation diminishes as we recede from that line, in accordance with its diminished circumference.

While the Earth is thus continually turning on its axis, it has also a progressive or onward motion in its *orbit,* that is, its *path round the sun.* The length of this orbit has been estimated at about 600 millions of miles, and the rate of the Earth's motion in its orbit to exceed 68,000 miles in an hour. The Earth's orbit or path is not circular, but *elliptical* or *oval shaped,* in consequence of which the Earth is not always at the same distance from the sun, but its average distance is 95 millions of miles. The Earth completes this revolution round the sun in 365 days and 6 hours, which constitutes a year.

The Earth, while performing its annual course round the sun, has not its axis placed at right angles with the line it pursues, but in an *oblique* or *slanting* direction; the consequence of which is, that the Earth presents to the action of the sun's rays a greater portion of the northern hemisphere during one half of the year, and a greater portion of the southern hemisphere during the other half of the year. The period at which any particular portion of the Earth's surface is turned most directly towards the sun constitutes *mid-summer* at that particular locality; and it will at the same time be *mid-winter* at the opposite portion of the globe. Thus, when it is mid-summer in the British Isles, it will be mid-winter at the little island of Antipodes, not far from New Zealand.

III. LATITUDE AND LONGITUDE.

THE globe or earth, for the convenience of measurement, is divided into degrees of latitude and longitude; these degrees being indicated by this sign, °.

Latitude is marked by lines or circles running *parallel* or even with the equator, each hemisphere being divided into ninety of these lines or degrees between the equator and the north and south poles. The reckoning commences from the equator, and is distinguished as *north* and *south latitude*. The latitude of any place is therefore determined by its distance north or south of that line. Thus London is in *north* latitude 51½°. Algoa Bay, near the Cape of Good Hope, is in *south* latitude 34°. Any place situated on or near the equator is said to be in a *low latitude;* any place near the Arctic circle to be in a *high latitude*. Thus, Sierra Leone is in the low latitude of 8½° N., Archangel in the high latitude of 64½° N.

Each degree is divided into sixty minutes, marked thus, ′; the exact latitude of London being 51° 38′; that is, fifty-one degrees, thirty-eight minutes. The number of miles comprised in a degree of latitude is nearly seventy.

Places situated in the same degree of latitude are said to be on the same *parallel*. Thus, Norwich and Berlin are on the same parallel of latitude, about N. lat. 52½ degrees.

The globe has a further division, also running parallel with the equator, which consists of four *circles*, called the *Arctic circle*, the *Antarctic circle*, the *Tropic of Cancer*, and the *Tropic of Capricorn*. The tropics are situated at the distance of 23½° north and south of the equator; the Arctic and Antarctic circles 23½° from the north and south poles, or in north and south latitude 66½ degrees.

These circles divide the earth into five *zones*, or belts, the *torrid zone*, the two *temperate zones*, and the two *frigid zones*. The torrid zone, so called from the heat of that portion of the earth which it includes, extends to 23½° on each side of the equator; that is, to the tropic of Cancer on the north, and the tropic of Capricorn on the south, of the equator. This zone is called *inter-tropical*, from its lying between the tropics. The northern temperate zone extends from the tropic of Cancer to the Arctic circle, and the southern temperate zone from the tropic of Capricorn to the Antarctic circle; that is, respectively from north and south latitude 23½° to north and south latitude 66½°. The frigid zones extend from the Arctic and Antarctic, or polar circles, to the north and south poles; that is, from north and south latitude 66½° to north and south latitude 90°. They are called frigid, from the cold temperature which prevails in those regions.

The *longitude* of any place is determined by its distance eastward or westward from any given point on the earth's surface. In Britain, *London* (or, more correctly speaking, the *Royal Observatory at Greenwich*) forms the *meridian* or station from which longitude is calculated.

For the measurement of longitude, the equator is divided into 360 parts or degrees; the same division into 360 degrees being maintained in all parallels of latitude, though, since the girth or circumference of

places in the same longitude. Thus, Bordeaux is on the same meridian as London, and therefore it will be noon, or mid-day, at the same time at both places. It will be noon *earlier* than in London at all places situated to the *eastward* of that meridian, or in *east longitude*, and *later* at all places situated in *west longitude*. The sun will rise rather sooner at Canterbury, and rather later at Bristol, than in London. At Calcutta, which is situated in east longitude 88° 29′, it will be noon when it is a little after six in the morning in London; and at the Feejee Islands, in the Pacific Ocean, which are situated nearly at the point where east and west longitude meet, it will be noon, or mid-day, when it is midnight in London. The sun is said to be *on the meridian* at mid-day: it is then due south, and at its greatest *altitude*, or height, for that particular day.

IV. GENERAL DISTRIBUTION OF LAND AND WATER.

The land does not occupy much more than one-fourth of the entire surface of the globe, the remainder being covered by the waters of the ocean. Thus, the extent of the whole surface being estimated at nearly 197,000,000 square miles, the space occupied by land is considered to be about 52 million square miles, and that covered by the waters of the ocean about 145 million square miles.

The proportion of land is much greater in the northern than in the southern hemisphere; it having been computed that in the northern hemisphe-

OUTLINES

OF

PHYSICAL GEOGRAPHY,

FOR

FAMILIES AND SCHOOLS.

BY

ROSINA M. ZORNLIN,

AUTHOR OF "RECREATIONS IN PHYSICAL GEOGRAPHY,"
ETC. ETC.

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PREFACE.

PHYSICAL GEOGRAPHY has of late years become a subject of such general interest, and now takes so prominent a place among popular sciences, that some acquaintance with its aim, and the views it unfolds, may be considered as one of the requirements of education. To facilitate the attainment of this knowledge, is the design of the present little work, in which the subject is placed before the reader in familiar language, and in a concise form, thus adapting it not only for the scholar, but also for the parent and teacher, and for all who, from previous inattention to this branch of knowledge, may be desirous of forming a ready acquaintance with the leading principles of the science.

Physical Geography owes its present state of forwardness to the combined observations of numerous individuals; and perhaps may be considered as dating its great advance from the era of the general peace of 1815; for it has only been subsequent to the cessation of war, that scientific men of various nations have obtained free access to different stations on the earth's surface, where observations have been successfully carried on; and it is by the mutual interchange of information thus gathered, that a large portion of our knowledge of Physical Geography has been acquired.

We have said that this science owes its great progress to the combined observations of numerous individuals;—we may also add, that it invites its student to observe, to give his attention to all that is passing around him in the natural world, and to verify for himself, as far as circumstances will admit, the truth of the data thus presented to his view. He may even lend his aid to the furtherance of this science. Instances are not wanting, both in our own day and in former times, of individuals from every class of society raising themselves to eminence by the pursuit of science; and the path is open to all. The inhabitant of the country may doubtless in this respect possess greater advantages than the dweller in crowded cities: he may take note of the minerals and plants in his own immediate neighbourhood, or may [illegible] his attention to the habits of birds and insects, and by recording his observations, may contribute his quota to the general mass of knowledge. But the dweller in towns may also perform his part: he may observe the ever-varying clouds, the temperature, the climate, of the place of his abode. He, too, may enjoy opportunities denied to the other, of ready access to works of travels, and thus be enabled to trace the application of the knowledge he has acquired to all parts of the globe. Had our limits permitted, we would gladly have attempted this application in the present little treatise; but having already in a former work,* with this especial object in view, carried our friends over the various regions of the earth, we must now content ourselves with tracing the OUTLINES OF PHYSICAL GEOGRAPHY, trusting that these will be found of sufficient interest to induce our readers to pursue the subject into its more minute details.

R. M. Z.

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* Recreations in Physical Geography.

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PHYSICAL GEOGRAPHY.

I. THE OBJECTS OF PHYSICAL GEOGRAPHY.

PHYSICAL GEOGRAPHY, or, in other terms, NATURAL GEOGRAPHY, consists of a description of the Earth we inhabit, and directs our attention to its structure, to the waters on its surface, to its atmosphere, to its various animal, vegetable, and mineral productions, and to the laws by which these are governed.

It is called *Physical* or *Natural Geography*, because it considers the Earth under its natural features, that is, according to the nature imparted to it by its Almighty Maker, and not in reference to any artificial divisions made by man, into kingdoms and states. We are thus led to regard the Earth as one great whole; and regions are determined by natural conditions, such as the climate or temperature of any portion of the Earth's surface, the prevalence or absence of particular species of plants, &c.

Physical Geography is a science of great utility, because it makes us acquainted with much that tends to man's benefit and prosperity. It also forms a very gratifying pursuit, for it presents us with numberless highly interesting facts in the natural world, which might otherwise pass unheeded, and it displays to our view the wisdom and goodness of the great Creator of the Universe.

it is traversed. Other parts consist of dense forests alternating with *prairies*, or extensive natural meadows, abounding in wild animals.

In South America three remarkable plains or lowlands occur. The basin of the river Oronoco forms the most northern; these plains are usually called *llanos;* the second great plain is that which is traversed by the mighty river Amazonas, and which extends from the shores of the Atlantic to the base of the Andes, having a gradual slope, and being in many parts covered with almost impenetrable forests, and in others with luxuriant herbage. These plains are distinguished as *silvas* or *llanos*. The third great lowland of South America, which includes the vast plains of Buenos Ayres, and extends to the cheerless wastes of Patagonia, forms the basin of the rivers Paraguay and La Plata. These plains are usually termed *pampas*.

Valleys are of three kinds:—*Principal valleys; lateral* or *transverse valleys;* and *subordinate valleys.*

Principal valleys are usually valleys of large dimensions, enclosed between extensive parallel ranges of mountains. To this class belongs the *Valais*, or *Valley of the Rhone.* This valley is bordered on the south by the Helvetian or Swiss Alps, and the Pennine or High Alps, among which we meet with Mont Blanc, and some of the other most elevated mountain peaks in Europe; and on the north it is bordered by the imposing mass of the Jorat Alps, where the scarcely less elevated Finster-aar-horn raises its peaked summit.

Lateral valleys, or *transverse valleys*, are so termed, hey are situated among and formed by the lateral or transverse branches of mountain ranges, and their size and general arrangement therefore depends on the magnitude and direction of the mountains among which they occur.

Subordinate valleys, as the name implies, are valleys of subordinate or smaller size, which are formed by the spurs or minor branches of mountain ranges, or which are situated among hills.

Some valleys are *basin-shaped*, or of a circular form, being surrounded by a girdle of mountains with the exception of one small outlet, which allows of the escape of the superabundant waters. Such valleys appear to have formed the beds of lakes at some previous period, the waters of which having been drained off through the small gorge or outlet, the lake has been converted into a fertile valley. The beautiful valley of *Cashmere* presents an example of a basin-shaped valley.

When valleys are narrow and difficult of access, they are termed *ravines*, *glens*, *dells*, *defiles*, *gorges*, *gullies*, *passes* or *ports*. Narrow valleys of this description are of frequent occurrence among steep mountains, and often present scenes of great beauty and grandeur. They usually form the routes by which mountain ranges are crossed, and hence they are called ports in the Pyrenees, and passes in the Alps and various other mountain ranges. As they are not situated at the highest point, but just below the head or summit of the mountain, they are called *cols* or *necks* in the Alps of Europe. They frequently form the beds of rivers which take their rise amid the snows of mountain regions.

The valleys and plains to which our attent hitherto been directed, though low in elevation as compared with hills and mountains, are all more or less above *the level of the sea,* which latter forms the standard by which all the undulations on the earth's surface are measured. In Central Asia a large tract of country exists which is depressed *below* the sea-level. This extensive area includes the *Caspian Sea* and the *Sea* or *Lake of Aral.* The surface of the Caspian Sea is 101 feet below the level of the ocean.

VI. GEOLOGY.

Geology consists of an inquiry into the nature and arrangement of the various rocks and other substances at or near the surface of the earth.

The portion of the earth which is accessible to man's observation is termed the *earth's crust,* though this forms but a very small part of the whole globe, for the deepest mine hitherto explored, scarcely penetrates more than half a mile into the interior of the earth, and the inequalities on its surface arising from mountains and valleys, have been well likened to the roughness on the rind of an orange, as compared with the general mass.

An examination of the earth's crust shows us that it is formed of numerous beds or *strata* of rocks, some of *limestone,* some of *sandstone,* some of *clay;* some very hard, others soft and crumbling, and readily worn away by the action of running streams, or the waves of the ocean. The greater number of these beds contain *organic remains,* that is, the re-ains of animals and plants, which are termed *fos-*

Among these the most numerous are the remains of marine animals; in some instances shells and corals occur in such abundance as to form the principal part of extensive beds. Every part of the earth exhibits similar, or nearly similar formations; and not only are marine fossils met with in the interior of continents and at great elevations above the sea, but a vast variety of plants, corals, shells, fish, reptiles, &c. &c., are met with in a fossil state, of species dissimilar to any at present existing on the land or in the waters.

Besides rocks, we meet with *earthy formations* on the earth's surface. These include such loose materials as are *disintegrated* or worn away from rocks, and form, when combined with decayed animal and vegetable matter, or *humus*, the soil of meadow and arable lands, and, generally speaking, all beds which are not *consolidated*, or hardened. *Water-worn pebbles*, that is, fragments of rocks, rounded by friction and the action of water, are of frequent occurrence, forming *gravel* in the beds of rivers, &c., and *shingles* on the sea-shore. When of very large size they are termed *boulders*.

When rounded pebbles become cemented together by lime or any other material, so as to form a solid rock, the mass is called *conglomerate*, and sometimes *pudding-stone*. When angular fragments are thus cemented together, the term *breccia* is substituted.

The most abundant materials or *earths* of which rocks are composed are, 1, *silica* or *flint*; 2, *lime*; and 3, *alumina* or *clay*.

Silica, *silex*, or *quartz*, is very universally diffused over the earth's surface. It is found in a pure state in *flint*, *agate*, *opal*, *chalcedony*, *rock crystal*.

the *flinty sand* of the sea-shore. Water passes freely through sand; and accordingly, sandy tracts do not retain water so as to promote vegetation, and they are therefore usually barren; of which the Sahrà presents a striking example.

Lime is also a very generally distributed earth, and is usually found in the form of *carbonate of lime.* Under the several names of *marble, limestone, oolite,* and *chalk,* it constitutes mountains, and even ranges of mountains.

Alumina or *clay,* called also *argil,* is likewise a very abundant earth, and of great importance to mankind. It forms part of various kinds of rocks, and its especial utility arises from its property of not permitting water to pass through its substance—a property which renders it of inestimable value, both for natural and artificial reservoirs of water.

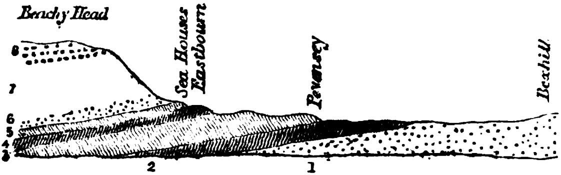
The beds or layers of rocks which form the crust of the earth are divided into *stratified* and *unstratified.*

Stratified or *sedimentary* rocks are such as bear evidence of having been formed by successive deposits of sediment in water. They are called stratified, because the materials of which they are composed appear to have been deposited in successive *strata* or *layers;* they are also called *aqueous,* because this appears to have been effected by the agency of *water;* they include *sandstones* or *freestones, limestones, clays,* &c.

Stratified rocks being formed by successive deposits of layers of sedimentary matter by means of water, it is evident that these materials must be derived from some source, and in many instances this may be traced to the *disintegration* or *crumbling away* of older rocks. Thus *gneiss* appears to be formed by the disintegration of *granite, conglomerate* by that of various kinds of rocks.

Although all the different kinds of stratified rocks do not occur in every part of the earth's crust, they are found to form a regular series, and those which are of more recent formation have never been met with under those which are considered as more ancient. Most of the stratified rocks contain fossils; and since each group contains a certain number of fossils peculiar to itself, it is by means of these organic remains that the relative ages of the different strata have been determined.

But although the lowest stratified rocks are more ancient than those which have been deposited above them, the layers or beds do not always retain a horizontal position. Were such the case, it could only be by means of deep cuttings that we should arrive at the older strata ; we, however, find, that owing to some convulsions of the earth, stratified rocks, and in some instances whole series of stratified rocks, have been thrown out of their original horizontal position, and thus the various beds *crop out* or come to the surface, as in the accompanying cut, where we perceive that no less than five different kinds of rock come to the surface from under the chalk.



GEOLOGICAL SECTION FROM BEACHY HEAD TO BEXHILL.

1. Hastings Sand.
2. Weald Clay.
3. Lower Greensand.
4. Gault.
5. Upper Greensand.
6. Chalk Marl.
7. Pure White Chalk.
8. Chalk with Flints.

Facility is thus afforded us, not only to become acquainted with the nature of the lower rocks, but many of the most valuable products of the earth are by this means rendered more accessible to man.

Unstratified rocks are such as appear to be of *igneous* origin; that is, to have been formed by the action of *fire* or *intense heat;* they are called unstratified, because, instead of having been deposited in successive layers, like the stratified rocks, they seem to have been formed by the *fusion* or *melting* of the materials of which they are composed, and the subsequent cooling and hardening of the melted matter into one great mass. *Granite, basalt, lava,* &c., belong to this class of rocks.

UNSTRATIFIED ROCKS.

Unstratified rocks may be divided into three sses :—1. *Plutonic ;* 2. *Trap ;* 3. *Volcanic,* *Plutonic rocks* are rocks which appear to have been formed at a considerable depth in the interior of the earth by the agency of heat, and in consequence of their having *cooled under the pressure of superincumbent*, or *over-lying rocks*, to have become greatly compressed and hardened. The principal rock of this class is *granite*, which is a very universally diffused rock, though in very many parts of the earth it is concealed from our view by the stratified rocks which rest upon it. In some parts, granite veins or branches extend upwards into the stratified rocks. Granite occurs in Cornwall and in various parts of Scotland.

Trap rocks are formations which are considered to be the products of *volcanos which have been long extinct*. These rocks, like the Plutonic, are supposed to have been in a state of fusion, but to have *cooled down under the pressure of deep water*, probably of a profound ocean. *Basalt* is one of the most abundant rocks of this class. It sometimes occurs in tabular masses, but more frequently in regular columns, usually called *basaltic columns*. The *Giant's Causeway*, in the north of Ireland, presents a remarkable instance of a formation of this kind.

Volcanic rocks are less compact and less hardened than either plutonic or trap rocks, which is supposed to be owing to their having *cooled in the open air*. The principal volcanic rocks are, *tufa* or *calc tuff*, *pumice-stone*, and *obsidian*. *Loose sand*, *scoriæ* or *cinders*, and *ashes*, are also ejected from the *craters* or mouths of volcanos, and some volcanos pour forth streams of muddy water, whilst all emit vol gaseous matter and steam.

The regions where volcanic action is at present displayed in the greatest energy include *Mount Vesuvius* and *Mount Etna,* and the adjacent seas; the *islands* of the *Indian Archipelago; Central America* and the *Andes;* some of the *islands* of *Oceanica; Iceland* and *Kamtchatka,* in the cold regions of the north; and *South Victoria Land,* amid the perpetual snows of the southern polar regions.

Terrific as are the effects sometimes produced by volcanic eruptions, there seems reason to conclude that in many instances they may rescue the districts where they occur, from the yet more destructive visitations of earthquakes. For it appears that the melted matter in the interior of the earth being enlarged in its volume by the action of internal heat, strives to force its way through the rocks which form the earth's crust; but on encountering the outlet afforded it by the crater of a volcano, this melted matter pours forth on the surface of the ground. The melted matter or lava ejected by the volcano of *Skaptar Yokul,* in Iceland, in the year 1783, was of immense volume. Two streams of lava flowed in opposite directions, the width of one stream being about twelve or fifteen miles, its depth about one hundred feet, and it extended to about fifty miles from the mouth of the volcano. The second stream was of equal depth, but not so great width, nor did it extend beyond forty miles. Had this mighty mass of melted matter not found a vent, we may well suppose that it might have shattered the rocks to atoms, and given rise to the most fearful earthquakes. And in fact it nfrequently happens, that in volcanic regions, akes cease at the very moment that eruptions commence from adjacent volcanos, and occasionally even from volcanos comparatively remote from the convulsion. It thus appears that in certain portions of the earth's crust, underground communication must extend to considerable distances. This is strikingly displayed in the *Andes*, and a wide extent of country at their base.

The effects produced by earthquakes are sometimes very remarkable, convulsions of this kind occasionally agitating immense tracts of country, shattering and displacing rocks, and even permanently raising continuous tracts of land above their former level, or causing the depression of others; thus effecting great alterations in the surface of the countries where they occur.

Earthquakes of great severity sometimes occur in regions remote from any active volcano; of this the tremendous convulsion which took place at Lisbon in the year 1755 forms an instance, and on that occasion the agitation of the earth's crust extended to the British Isles, and even to the West Indies and some parts of North America. Slight tremors of the earth are occasionally felt in all parts of the globe. Convulsions of this description have been not unfrequently experienced in Great Britain and (more particularly of late years) in Scotland.

Extinct volcanos occur in various parts of the earth's surface; and in such cases we may infer, that though at some former period earthquakes and volcanic eruptions may have taken place in those localities, these have now ceased, and the melted mass has cooled down, and formed a solid rock.

Igneous rocks have in many cases forced th up through stratified rocks, forming what are termed *intrusive rocks*, because they have *intruded* into the region of rocks of another class. These igneous formations, whilst still in a molten state, and intensely hot, coming in contact with the aqueous or stratified rocks, have usually changed the character of those portions immediately near them, thus forming what are called *metamorphic* or *transformed* rocks. By such means *limestone rocks* have become transformed into *crystalline marble.*

The effects produced at remote periods by violent convulsions of the earth may also be traced by the *dislocations* or *faults* to which they have given rise. A *dislocation* or *fault* is so named because any bed or stratum of rock where it occurs has been rent asunder and *dislocated* or *displaced,* and one portion being either raised above or depressed below its former level, and being therefore no longer entire and continuous, an interruption or *fault* takes place.

As sandstone and limestone rocks permit water to *percolate* or *pass through* their substance, which clay does not, these dislocations or faults are of great importance in the natural world, the clay strata frequently, in consequence of their altered position, arresting the water, and causing it, instead of remaining concealed beneath the surface in an extended sheet, to gush out in the form of a spring at the point where the dislocation has occurred. The *fissures* or *crevices* where these displacements have taken place not unfrequently are found filled with clay and other materials, which arrest the water in its progress.

In some localities fissures are found to contain substances, and are then distinguished as *metallic veins.* Such fissures are frequently found partially filled with *calcareous spar* or *crystallized carbonate of lime,* which forms the *matrix* or *covering* in which the metals are enclosed.

Metallic or *metalliferous* veins are supposed to have been partly filled by *mechanical means,* that is, by particles of metallic substances being conveyed into them by the action of water or some other power; and partly by *chemical action,* that is, by *sublimation,* or *fumes rising from below,* causing deposits to take place in these fissures. The rich lodes or metalliferous veins of Cornwall occur in fissures, more than one dislocation having in many instances apparently taken place.

Some metallic deposits appear to occur in situations where igneous rocks have intruded themselves into, and converted stratified rocks into crystalline rocks. Gold is supposed almost invariably to be found under such circumstances. Such appears to be the case in the rich deposits near the Ural mountains in Asiatic Russia; as also in California and in Australia; in all which places it is met with in *quartz.* It is in pebbles and sand of the same rock that it occurs in the beds of rivers, and in some cases is found spread over a large extent of country.

Copper, though frequently met with in veins, is also found in extensive masses or beds, interposed between layers of rock. The same remark applies to *tin, lead,* and *silver. Iron* is a very generally diffused metal, and is met with in beds, and also in *nodules,* or rounded masses, which occur in great abundance among some kinds of rocks.

STRATIFIED ROCKS.

Stratified rocks are arranged in four classes:—1. *Metamorphic.* 2. *Primary Stratified.* 3. *Secondary Stratified.* 4. *Tertiary.*

1. *Metamorphic* or *Stratified crystalline rocks* include *gneiss, clay-slate, quartz,* &c. These rocks appear to have been formed in layers or strata, like ordinary stratified rocks, and subsequently to have been subjected to intense heat, which has *metamorphosed* or transformed them into crystalline rocks, and hence they are termed metamorphic or transformed. No fossils have hitherto been discovered in these rocks; probably the intense heat to which they have been subjected may have destroyed nearly all traces of organic remains. *Statuary marble,* which consists of limestone, transformed into the crystalline substance called marble, belongs to this class of rocks. It is met with in some parts of Scotland. *Gneiss, clay-slate,* &c., also occur in Scotland, in Wales, and in some other parts of the British Isles.

2. The *Primary stratified rocks* comprise four groups: 1. Silurian; 2. Devonian; 3. Carboniferous; 4. Permian.

The *Silurian rocks* occur abundantly in some parts of Shropshire and Wales; the group having been named from the ancient Silures, who formerly occupied the soil, and made a stand against the Romans under their brave leader, Caractacus. The older rocks of this group are sometimes distinguished as *Cambrian,* from their occurrence in Wales. The an rocks consist of limestones, sandstones, and shale. The principal fossils are *corals, marine shells,* and *trilobites,* which are found in great abundance in the Wenlock and Dudley limestone, and near Ludlow, in Shropshire. The remains of *fish* have been found in some of the rocks of this group; and also *fossil foot-prints* of a *reptile,* apparently bearing some resemblance to the tortoise.

The *Devonian system* or *group,* (sometimes called the *old red sandstone*) occurs in South Devon and Cornwall, in Herefordshire, and in some parts of Scotland. The beautiful marbles of Torquay and Plymouth belong to this group. In Herefordshire and Forfarshire we meet with red sandstones, and in other parts with grey sandstones, &c. The fossils include beautiful *corals, trilobites* and *mollusca,* or *shell-fish;* and the sandstones of Scotland abound in the remains of singularly-formed *fish,* peculiar to this group.

The *carboniferous* group is subdivided into the *mountain limestone* and the *coal measures.*

The *mountain limestone* in the north of England alternates with the coal measures. It consists of a grey, compact, crystalline limestone, and contains numerous fossils, among which are *corals* and various species of *marine shells.* The mountain limestone in the vicinity of Matlock, abounds in the fossils characteristic of this group.

The various formations we have hitherto considered have contained only *marine remains,* and as yet no traces have been discovered of land plants in any of those rocks. In the *coal measures,* on the contrary, the fossils consist almost wholly of the r
of *land plants,* accompanied by some *lan*

and *fresh-water shells*, the coal itself being formed of vast accumulations of *vegetable matter*.

The *coal-measures* in some parts are of immense thickness; thus, in South Wales, they attain the extraordinary depth of 12,000 feet. In the north of England, the thickness of the coal-bearing strata has been estimated at 3000 feet; but the coal itself forms a very small part of the whole mass, the *seams* or beds of coal in that district scarcely exceeding sixty feet in thickness. The beds which alternate with these seams of coal, consist chiefly of sandstone and shale, the latter slaty substance being frequently met with among the refuse under our grates. The coal formation occurs in Northumberland and Durham, in parts of Yorkshire, Derbyshire, Staffordshire, Gloucestershire, Somersetshire, and South Wales. It is met with in Scotland, in the valleys of the Forth and Clyde; and also in various parts of Ireland. The shales which intersect the layers of coal often abound in beautiful fossil *land plants;* these are also frequently met with in an excellent state of preservation in iron-stone nodules, which occur abundantly in some coal-fields, particularly in the Derbyshire and Staffordshire districts. The number coal-plants hitherto discovered amounts to about 50 among which 250 are *tree-ferns*. Very fine sp cimens are obtained from the Jarrow colliery ne Newcastle. The remains of *fresh-water fish* a *shells*, of *insects*, and of some *land reptiles*, have al been found in the formations of this group.

he *Permian group* includes some red sandsto h occasionally contain *rock salt;* also the r magnesian limestone, which occurs in Yor shire and Durham; and *dolomitic* or magnesian conglomerate, which occurs near Bristol and in other parts of Somersetshire, and which contains the remains of *fish* and also of *saurians* or *reptiles*, in some degree resembling lizards. *Fossil trees* have been discovered in some of the formations belonging to this group.

3. The *Secondary stratified rocks* include five groups :—1. *Trias;* 2. *Lias;* 3. *Oolite;* 4. *Wealden;* 5. *Cretaceous.*

The *Trias* group, (sometimes called the *new red sandstone*) occupies a considerable portion of the central counties of England. It consists of red and white sandstones, variegated and other clays, gypsum and marl, &c. The chief deposits of *salt*, both in England and other countries, are met with in the formations of this group. In Cheshire, salt occurs in beds of *marl*, which consists of a mixture of clay and lime. Some of the rocks belonging to this group contain *marine fossils*, and others, *land plants* and *reptiles;* the latter are supposed to have resembled toads of a gigantic size; and *fossil foot-prints*, apparently belonging to the same kind of animal, have also been found at Storton Hill, near Liverpool, and in various other places. Fossil *footmarks of birds* have been discovered in rocks belonging to this group.

The *Lias* group consists chiefly of *argillaceous* or *clayey* limestone, marl, and clay, usually of a bluish grey colour. It is met with in Yorkshire, Leicestershire, Gloucestershire, Somersetshire, Dorsetsh
The fossils of the Lias are numerous, an

interesting. They are chiefly marine, and include *encrinites, crustacea, mollusca,* some peculiar kind of *fish*, and *sea lizards*, or *saurians* adapted for inhabiting the sea. These comprise the *ichthyo-saurus* and the *plesio-saurus*. The fossils of this group abound at Scarborough, Cheltenham, Bath, Bristol, Lyme Regis, &c.

The *Oolite* group (sometimes called *Jura limestone*) consists of *oolitic* (that is, egg-like, resembling the roe of a fish) shelly and coralline limestones, fullers'-earth, sandstones, and blue clay. It is met with in Yorkshire and in the midland counties, in Somersetshire, Wiltshire, Dorsetshire, &c. It is known as *Bath oolite* in the neighbourhood of that city; as *coral rag* in the vicinity of Oxford, and as *Portland building stone* in the Isle of Portland. Some of the formations contain marine fossils, such as *corals*, *encrinites, mollusca, fish,* &c. Other rocks contain *fossil trees, insects, tortoises, land lizards* and *flying lizards*, or *pterodactyles*. Small *quadrupeds*, in some respects resembling the opossum, have also been discovered in the oolitic formations. Fossil shells belonging to this group abound near Scarborough; they are also met with at Bath, Cheltenham, &c.

The *Wealden* group appears to be of fresh-water origin. It consists of sandstones and clays, with layers and nodules of limestone. It forms the *Purbeck beds* in the Isle of Portland; the *Weald clay* of Horsham, and other parts of Sussex and Kent; the *Hastings sand* of Hastings and Tunbridge Wells; and the *shelly limestone* called *Sussex marble* of tworth, &c. This group is remarkable for the ains it contains of *gigantic land reptiles*, including the *iguanodon*, more than seventy feet in length. *Fresh-water shells*, and other fossils of the Wealden group are met with abundantly at Hastings, Tunbridge Wells, &c.

The *Cretaceous group* has four subdivisions:—1. *Lower Greensand; 2. Gault;* 3. *Upper Greensand;* 4. *Chalk.*

The four divisions of the cretaceous group, as also two belonging to the preceding group, are well displayed near Eastbourne, in Sussex, where they *crop out*, or come to the surface, as shown in the Geological section from Beachy Head to Bexhill, page 28. The most ancient formation in this series is that called Hastings sand, fig. 1; on that was deposited the Weald clay, fig. 2; both of which are included in the Wealden group. The next in ascending order is the Lower greensand, fig. 3; on this was deposited the blue clay, called gault, fig. 4; and then a layer of Upper greensand, fig. 5. Above this was deposited the chalk formation, the lowest part of which consists of chalk marl, fig. 6; the middle of pure white chalk, fig. 7; and the upper part, at Beachy Head, of chalk with layers of flints, fig. 8.

The *Lower greensand* consists of *ferruginous* or *irony* and other sands, and some limestone. It is met with in Kent and Sussex, and in the Isle of Wight. The limestone called *Kentish rag* belongs to this formation. *Gault* is a dark-blue marl, and is found below the chalk of Kent and Sussex. The *Upper greensand* forms the *firestone* of Merstham, in Kent; and the loose, crumbling, sandy cliffs near Eastbourne and Sandgate, &c. The fossil *sh* the greensand are abundant near Shanklin Chine, in the Isle of Wight; of both the greensand and gault, at Folkestone.

Chalk consists generally of a pure white calcareous mass, not sufficiently hard to form a building stone. The upper part of the chalk formation frequently contains layers or nodules of flint, disposed in regular strata. The lowest part of the chalk often consists of a softer material, called chalk marl. The chalk formation extends from the coast of Yorkshire near Flamborough Head, to the south of England, where it forms the North and South Downs. It does not, however, appear at the surface in all parts, being concealed beneath tertiary formations. The fossils are very numerous, and chalk is sometimes almost wholly formed of minute *shells* and *corals*. The flint nodules also often contain fossils. *Corals*, *sponges*, *star-fish*, *sea-urchins*, a great variety of *shells*, numerous species of *fish*, *turtles*, *reptiles*, &c. are among the fossils of the chalk. They are met with at Brighton, Worthing, Dover, &c.

4. The *Tertiary stratified rocks* comprise the *Eocene*, *Miocene*, and *Pliocene* groups or periods.

The *Eocene* group includes the *London* and *Plastic clays*, which are met with in the neighbourhood of London, and on which the metropolis is built. The *Bognor beds* also belong to the Eocene group; as do also the *Bagshot sands*, which occupy extensive heath-covered tracts in Surry and Hampshire. The fossils of this group are very numerous, and include ious kinds of *fruit*, beds of *lignite* or *imperfect* and *insects*; the remains of *crocodiles* and *serpents; birds*, and *terrestrial mammalia*, among which we find the *palæotherium*, and some other *extinct* kind of *animals*, and the *hippopotamus* and other *genera* of existing animals, though of different *species* from those at present inhabiting the warmer regions of the globe. *Marine shells* are also very numerous, and are met with in great abundance in the Isle of Sheppey, at Bognor in Sussex, Christchurch in Hampshire, &c.

The *Miocene* group is not known to exist in England, but is met with in France and Switzerland.

The *Pliocene* formations are met with in Suffolk, under the name of the red or *coralline crag*, and in Norfolk as the *Norfolk crag*. Many of the fossil shells of this group are of the same species as those found in the seas round the coasts of Great Britain. *Bone-bearing caves*, or caverns containing large accumulations of the *bones of animals*, mostly of extinct *species*, occur in England, and various other countries. *Kirkdale cave* in Yorkshire, and *Kent's cavern* near Torquay, are the most celebrated in England. The remains consist of various species of *hyæna, elephant, rhinoceros, &c.*

The tusks and other remains of the *mammoth, mastodon*, &c., have been found in gravelly deposits on the banks of the Thames near Brentford, and in various other parts of England, as well as in Northern Europe, Asia, and America. In some cases these remains are associated with the *boulder formation*. The *boulder*, or *erratic block* formation, consists of large rounded masses of rock, accompanied by *drift*, which bear evidence of having been transported from more northerly regions by agency of *glaciers*. The term *glacial period* is applied to this peculiar formation. Granite blocks appear to have been thus transported from the mountains of Cumberland to the Vale of the Severn.

Changes are in continual progress on the earth's surface; *coral reefs* become raised above the ocean, and formed into islands adapted for man's abode; *volcanos* not only eject lava and ashes, and volcanic dust in profusion, but form new cones of permanent duration; *vegetable matter* accumulates in great masses in peat bogs; whilst on the other hand *rocks crumble away*, partly from the action of the atmosphere, partly from that of running streams, and partly from that of the waves of the ocean; the sand and silt and mud thus brought down being again deposited, and forming new land, to which the term *alluvium* or alluvial soil is applied. In all these various formations, it not unfrequently happens that the remains of plants, of land animals, of fish, or of shells, become embedded, according to the localities in which the accumulations have taken place. We thus find in these and other changes at the present day occurring on the face of the globe, satisfactory explanations of many of the geological phenomena which have engaged our attention.

VII. THE WATERS OF THE GLOBE.

The waters of the globe may be considered under four heads:—1. *Springs;* 2. *Rivers;* 3. *Lakes;* 4. *The Ocean.*

Springs, or *natural fountains of water*, take their from reservoirs, or sheets of water stored beneath the surface of the ground. A sheet or body of water has a tendency to maintain the same level surface, or to rise to the same height, wherever it may spread; the height to which a spring will rise depends therefore on that of the surface of the reservoir of water from which it is supplied. If the internal reservoir of water be situated in a hill, and the spring should gush out in a valley, the water may rise to a considerable height above the surface of the ground, and form a natural fountain; but on the other hand, if the reservoir be situated at some depth below the surface of the ground, the water might never reach the surface, and the aid of a bucket or a pump might be required to obtain water from such a source.

These internal reservoirs of water are in great measure supplied by moisture derived from rain, snow, mist, and dew. This atmospheric water enters the earth through porous rocks, or by means of fissures, and continues to sink until arrested in its progress into the interior of the earth, by rocks such as clay, which will not permit water to pass, or else by faults, which check it from spreading into a wider sheet. The water then will gush forth as a spring of greater or less size, according to the supplies it may have received. The peaks or pointed summits of mountains, owing to the small surface they present for collecting the rain, snow, or dew, are not favourable for the formation of copious springs.

All springs contain a certain proportion of air and gas, and also some solid matter, usually in the form of salts. When this does not exceed a three-thousandth part of the whole, they are termed *soft*; but if the solid contents exceed this proportion, the water becomes *hard.* When these salts are in great abundance, the water becomes wholly unfit for domestic use, and *mineral springs* are formed. The largest spring in Great Britain is that of St. Winifrede's Well at Holywell, which is said to throw up about twenty-one tuns of water per minute, or 30,240 tuns daily.

Mineral springs may be divided into six classes: 1. *Acidulous ;* 2. *Chalybeate ;* 3. *Sulphureous ;* 4. *Saline ;* 5. *Calcareous ;* 6. *Siliceous.*

Acidulous waters present a sparkling appearance, which arises from their containing *carbonic acid gas.* Of this, the pleasant beverage called Seltzer water forms an example. Carbonic acid gas has the property of rendering soluble in water, the oxide of iron and various other mineral substances, and therefore these springs usually contain some earthy or saline ingredients. The springs at *Tunbridge Wells* belong to this class.

Chalybeate springs properly so called, are such as hold in solution, either the *carbonate* or *sulphate of iron.* A small spring of this description occurs at Wick, near Brighton.

Sulphureous springs contain *sulphur* either in the form of *sulphuretted hydrogen,* as the springs of *Harrogate ;* or in that of *sulphate of lime,* like the springs of *Baden* near Vienna.

Saline springs are of two kinds, *brine springs* and *medicinal salt springs. Brine springs* contain besides some other mineral ingredients, a greater or less pro- n of *chloride of sodium,* or *common salt,* some yielding one fourth of their weight in salt.

Very productive salt springs occur in Worcestershire. *Medicinal salt springs* are such as contain, in addition to *chloride of sodium*, various other kinds of salts, such as the *sulphate of soda* and *magnesia*, of which the *Cheltenham* waters afford an example.

Calcareous springs, or springs highly charged with *calcareous* matter, are met with in *limestone* rocks, from which they derive their calcareous ingredients. Water has the property of dissolving the calcareous rocks over which it flows, or through which it filters, and of again depositing it, so as to form as the water evaporates, an incrustation, and in process of time, a solid rock. The *Dropping Well* at *Knaresborough* affords an instance of such a spring. The water falls in the form of a shower from a projecting ledge of rock, and if plants, or shells, or the bones of animals are placed so as to allow the water to fall on them, they become embedded in the *tufa* or *travertin*, as it is called, and apparently converted into stone, in which state they may be permanently preserved. And hence these springs are usually termed *petrifying* or *mineralising springs*.

In some instances when water *percolates* or filters through limestone rocks into cavernous recesses, very beautiful formations called *stalactites* and *stalagmites* are met with. The stalactites being suspended from the ceiling of the cavern, like icicles of stone, and the stalagmites being formed by successive deposits on the ground, and rising in all varieties of form from the floor. Stalactites and stalagmites in some caverns meet and unite, presenting the appearance of columns supporting an edifice.

Siliceous springs are so named from holdi or *flint* in solution. These springs are all *hot* or *thermal*, as well as mineral springs. The most remarkable springs of this class are the *Geysers* of *Iceland.*

Thermal or hot springs are met with in all parts of the globe. They may be arranged in two classes: 1. Those which owe their high temperature to the natural heat of the earth at certain depths; and 2. Those which derive it from volcanic action.

It has been found that on penetrating into the earth below the depth of 100 feet, an increase of temperature takes place, both in solid rocks and in internal reservoirs of water, the increase being at the rate of about one degree of Fahrenheit's thermometer in 45 feet. And accordingly, springs which have their sources at greater depths, possess a higher temperature than those which derive their supplies nearer the surface. This has been proved by water obtained from Artesian wells at various depths.

The hottest springs are those situated near active volcanos. Among these the *Geysers* of Iceland hold a prominent place, their temperature being rather above the point of boiling water. Some springs connected with extinct volcanos have a very high temperature. Thus, the copious spring of Chaudes Aigues, in France, has a temperature of 174° Fahrenheit.

Some thermal springs occur in localities where faults or dislocations of the earth's crust have taken place. This is strikingly exhibited in the hot springs at *Matlock* and *Bristol.* The hottest spring in Great Britain is that called the *King's Well,* at *Bath,* which the temperature of 115°.

uminous or *petroleum springs,* that is, springs charged with *bitumien*, *petroleum*, *naphtha*, *asphaltum*, &c., are of common occurrence in volcanic districts, or in districts where traces of igneous action are distinctly observable.

RIVERS.

THE sources or first waters of *rivers* are usually derived from springs, or from the melting of accumulations of snow. They do not therefore receive their largest supplies from the actual summits of mountains, for copious springs are rarely met with in such situations, nor are glaciers formed on the highest points of mountains, but more usually on the declivities or slopes of the upper mountain valleys. It is accordingly in the latter localities that many of the largest rivers take their rise. Thus the Rhone has its source in the glaciers of the Alps, at the elevation of 10,000 feet above the level of the sea.

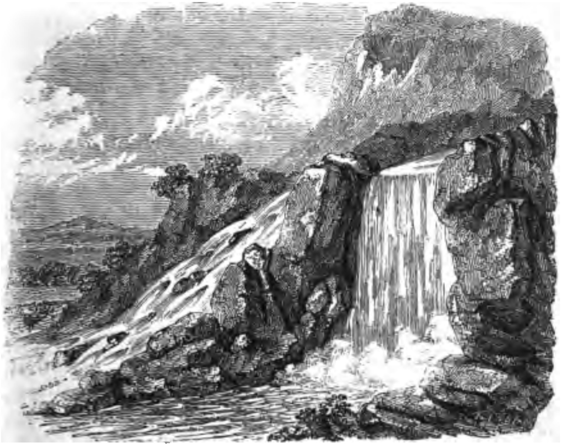
It not unfrequently happens that several rivers take their rise in one mountain ridge, some of the rivers flowing in one direction, and others taking an opposite course. This is termed the *water-shed*. Thus the mountainous districts of Westmoreland form the principal water-shed of the north of England. The Eden flows in one direction, the Tyne and Tees in another, the Ouse in a third, &c. The chief water-shed in Europe is formed by the Alpine system, and its prolongation into Germany. Thus the Rhine, the Rhone, and the Danube all take their rise in the Alps, the one discharging itself into the German ocean, the other into the Mediterranean, and the third into the Black sea. In Eastern Europe the water-shed is formed by the low ridge of the Valdai H not more than 1200 feet above the level of the sea. From hence the Volga flows, which pours its waters into the Caspian sea, the Dwina, which falls into the Baltic, and the Dnieper, which enters the Black sea.

The portion of country through the course of which a river lies, and which is drained by it and its tributary streams, is called its *basin*. The extent of the basin of the Thames is estimated at about 5000 square miles. The area drained by the river Thames and its tributary streams is very small, compared with that drained by some of the great rivers of the globe. The largest river basin in Europe, as will be observed in the following table, is that of the Volga, the largest in the world that of the Amazonas.

RIVER BASINS.	SQUARE MILES.
Thames	5,000
Rhine	89,000
Danube	312,000
Ganges	443,000
Volga	653,000
Mississippi	1,100,000
Amazonas	1,920,000

The velocity of a river depends in a great degree on the nature of the country in which it takes its rise, and which it traverses. The Thames has its source at an elevation of only a few hundred feet above the level of the sea, and since its whole course lies through a comparatively level country, it flows with a moderate velocity, and presents no instances of torrents, rapids, or waterfalls, a circumstance which renders it particularly available for the purposes of navigation; and thus though it may appear insignificant when compared with some of the mighty streams on the earth's surface, it possesses advantages superior to most rivers, having also an unimpeded entrance, and being navigable for large vessels to the very banks of the metropolis.

Rivers which take their rise in elevated mountain districts usually flow with great velocity in the earlier part of their course, rushing down in torrents, or leaping down in *cascades* or *cataracts.* When waterfalls are of an impetuous character they are generally termed *cataracts;* when more gentle, they are called *cascades.* Waterfalls are very numerous among the Alps and other mountainous regions. When a continued slope occurs in the bed of a river, *rapids* are formed.



RAPID AND CASCADE.

It occasionally happens that owing to local peculiarities at the mouths of rivers, accumulations of sedimentary matter take place in the middle of the stream, dividing it into two branches. This island, or mass of *alluvium*, which often assumes a triangular shape, is termed a *delta*. Instances of deltas occur in the *River Rhone*, both when it enters the Lake of Geneva and at the termination of its course in the Mediterranean sea.

Some rivers which fall into the ocean, and have *estuaries* or wide channels at their mouths, are subject to a great swell or sudden rise of the waters when the tide enters the river. This is called the *bore*. It occurs especially at spring tides, when a more than ordinarily large volume of water enters the mouth of the river. The bore may be observed in the *Severn*, and some other rivers of Great Britain, and is displayed on a grand scale in the rivers *Ganges*, *Amazonas*, &c.

Most rivers are subject to an occasional, and, in some instances, periodical increase in the volume of their waters. In the rivers of Great Britain these *flood seasons*, or *freshets*, as they are termed, are by no means regular, being partly dependent on the melting of the snows, and partly on occasional heavy falls of rain. In countries where the climate is less variable, these flood seasons in the rivers are usually periodical. Thus the flood season in the *Volga* being dependent on the melting of the snows in Northern Russia, takes place in June. The rise of the *Nile* being dependent on the periodical rains which fall on the mountains where its source is
st invariably begins to rise in the middle

of June, and the waters continue to increase until the end of August, or beginning of September, when the river is at its greatest height, and the whole valley of Egypt is usually inundated.

The number of considerable rivers which pour forth their waters into the ocean is estimated at about 440 in the Old World, and 140 in the New World.

The following table gives the length and situation, and also the termination of some of the principal rivers on the surface of the globe.

RIVER.	LOCALITY.	TERMINATION.	MILES.
Mississippi and Missouri .	United States .	Gulf of Mexico .	4200
Nile	Nubia and Egypt .	Mediterranean Sea	3600
Amazonas . . .	Brazil	Atlantic Ocean . .	3600
Yang-tse kiang .	China	Pacific Ocean . .	3300
Niger	Nigritia	Gulf of Guinea . .	3000
Mississippi proper	United States .	Gulf of Mexico .	2400
Volga	Russia	Caspian Sea . .	2200
La Plata . . .	Brazil and La Plata	Atlantic Ocean .	2200
St. Lawrence . .	Canada	Gulf of St. Lawrence	2000
Indus	Hindostan . . .	Indian Ocean . .	1800
Danube	Germany, &c. .	Black Sea . . .	1700
Euphrates . . .	Turkey in Asia	Persian Gulf . .	1700
Oronoco	Venezuela . . .	Atlantic Ocean .	1550
Ganges	Hindostan . . .	Bay of Bengal . .	1500
Colombia or Oregon . .	United States .	Pacific Ocean . .	1500
Dnieper . . .	Russia	Black Sea . . .	1200
Gariep or Orange .	South Africa . .	Atlantic Ocean .	1050
Ural	Russia	Caspian Sea . . .	950
Rhine	Switzerland, Germany, & Holland	North Sea . .	760
Elbe	Germany	. . . .	700
istula	Poland, &c. . .	Baltic Sea . . .	
agus	Spain and Portugal	Atlantic Ocean .	

RIVER.	LOCALITY.	TERMINATION.	MILES.
Rhone	Switzerland and France	Mediterranean Sea	490
Seine	France	English Channel	440
Po	Italy	Adriatic Sea	315
Thames	England	North Sea	215
Shannon	Ireland	Atlantic Ocean	190
Forth	Scotland	North Sea	115

LAKES.

Lakes are of different kinds. Some may be considered as tanks or reservoirs which receive the first outbreakings of a spring; and in lakes of this description, if the volume or quantity of water be of small amount, the evaporation from the surface may be sufficient to dispose of the whole supply from the spring; and therefore such a lake will require no outlet. Such is the case with a large number of small lakes and ponds in all parts of the globe. If the amount of water sent forth by a spring be more than will fill the hollow which forms the basin of the lake, the water will scoop out for itself a channel, and issue forth either in the form of a little brook, of a rivulet, or of a river. Many important rivers have their sources in small lakes. Thus the river *Volga* commences its course by issuing from the small *Lake of Ternoff*, the *Amazonas* from the *Lake of Lauricoch*, and the *Mississippi* from *Lake Itascu.*

Other lakes consist of basins or reservoirs which occur in the line of a river's course, into which its waters flow, and which, having filled the cavity, issue forth some other point. A river may form numerous f this kind in its onward progress. Thus th

Mississippi in the earlier part of its course, passes through no less than eight such lakes, some of which are of considerable size.

Some lakes consist of basins or cavities into which one or more rivers pour their waters, but which, owing to the porous nature of their beds, or to the depression of the region where they are situated, possess no outlet for the waters to escape, which therefore are either carried off by evaporation, or sink into the earth; and as the purer parts of the water are thus removed, a great deposition of saline matter usually takes place, and thus *salt lakes* are formed. To this class of lakes, or *inland seas*, belong the *Caspian Sea*, the *Lake* or *Sea of Aral*, the *Dead Sea*, or *Lake Asphaltites*, &c. The Dead Sea receives the river Jordan, the river Arnon, and the river or brook Cedron, but has no visible outlet, and its waters are more saline than those of the ocean.

Lakes are sometimes formed in the craters of extinct volcanos, and in such cases the waters are usually strongly impregnated with sulphur and bitumen.

Some lakes are *periodic;* that is, subject to have their basins alternately empty and full of water. Of this description is the *Lake of Zirknitz*, in Carniola.

The lakes in the British Isles are of small size. Windermere, which is the largest English lake, not exceeding eleven miles in length and one mile in width. The largest European lakes are the lakes of *Ladoga* and *Onega*, in Russia. The *Caspian Sea* may be considered as the largest lake on the face of the globe, its length being about 700 miles, and its about 210 miles. The surface of this vast salt lake or inland sea is 104 feet below the level of the ocean. North America contains the largest *fresh water* lakes in the world, a vast chain of connected lakes occupying a wide surface of country in its more northerly regions. This chain of lakes includes *Lakes Superior, Huron, Michigan, Erie,* and *Ontario,* the surplus waters of which, after having formed the grand *Fall of Niagara,* between Lakes Erie and Ontario, are discharged into the Atlantic by the river St. Lawrence.

THE OCEAN.

THE extent of the vast mass of waters called *the Ocean* greatly exceeds, as we have already seen, that of the dry land on the surface of the globe. This is an arrangement of great importance in the natural world, for abundant supplies are thus afforded, by *evaporation* from its vast surface, for the large amount of moisture required to water the earth, and which descends in the form of showers and dew.

The ocean consists of *one* great fluid mass; and in accordance with the laws by which fluids are governed, its waters flow into and occupy the great depressions on the Earth's surface which form its bed, maintaining a general level in all parts of the globe, whatever may be the undulations of the ground on which it rests.

Although thus in fact one mighty whole, the ocean has received in geographical descriptions several nominal divisions and subdivisions.

The two principal divisions of the ocean are those he *Atlantic* and *Pacific,* which are formed by o great continents. The *Austral* or *Southern*

Ocean may be regarded as forming a third division, and occupies that portion of the ocean not included in the two former divisions. Its limits may be traced by a line passing round the globe, and touching the Cape of Good Hope, Cape Horn, and the southern extremity of Tasmania (Van Diemen's Land).

The Atlantic Ocean is sometimes subdivided into three portions; the *Northern Ocean*, which includes the *Polar seas*, and extends to an imaginary line drawn across the ocean, from the southern extremity of the British Isles to the southern extremity of Greenland; the *North Atlantic*, extending from that line to the Equator; and the *South Atlantic* from the Equator to the southern extremities of Africa and America, that is, to the Austral or Southern Ocean.

The Pacific has also three subdivisions; the *North* and *South Pacific*, and the *Indian Ocean*. The division between the North and South Pacific is marked by the line of the Equator; and the latter extends to the southern coasts of Australia. The Indian Ocean comprises the seas extending from Australia and the western limits of the Indian Archipelago to the eastern coasts of Africa.

In various parts of the great continents, deep inlets, called *branch* or *inland seas*, occur, penetrating far into the interior, and communicating with the main ocean either by narrow straits, as the *Red Sea*, the *Mediterranean*, and the *Baltic;* or by wider channels, as the *White Sea*, the *Yellow Sea*, *Baffin's Bay*, &c.

Smaller inlets of the sea are of frequent occurrence, especially in districts where mountain ranges approach the borders of the ocean. Such are the *lochs* o Scotland, the *voes* of the Zetland Isles, and the *fi* of the coast of Norway. The term *lagoon* is usually applied to the lake-like inlets on the shores of the Adriatic sea, in the midst of one of which the city of Venice is built.

The ocean varies greatly in its *depth*, but is supposed, generally speaking, to be deepest at a distance from land, and shallowest in channels and straits and near islands, though it differs much in its depth in the immediate vicinity of dry land, according to the character of the surface, whether the shores may be flat, or rise abruptly from the sea. The *mean* or *average* depth of the sea round the comparatively level coasts of South Britain, is considered not to exceed 120 feet; off those of Scotland, to be about 360 feet; and off the western coast of Ireland, where rocks of a precipitous character abut upon the sea, to have the depth of about 2000 feet. In some parts of the mid-Atlantic Ocean the plumb-line has been let down to the depth of 27,000 feet without reaching the floor of the ocean.

The *temperature* of the ocean's surface appears generally to agree with that of the climate in which it is situated, that is, with the temperature of land at the level of the sea. In warm climates the temperature of the deep sea diminishes with the depth below the surface, until a certain depth is reached, below which it appears to retain a similar temperature, this being about 40° Fahrenheit. In the Polar Seas, where the temperature at the surface of the ocean is lower than 40°, the temperature is found to increase until it reaches that point. About N. lat. 70° the perature of the ocean is considered to be the same depths.

The waters of the ocean are *salt*, holding in solution various saline matters which impart to them a disagreeable taste, and render them unfit for the beverage of man. The saline ingredients amount to rather more than thirty-five grains in a thousand grains of sea-water. The most abundant of these is *chloride of sodium*, or *common salt*, which in general forms above one-third of the whole saline matter. Besides this, sea-water contains some *magnesia*, *lime*, *potass*, and traces of *iodine*, and *bromine*. The *specific gravity* or *weight* of sea-water is greater than that of pure water. Pure water (at the temperature of 60°), is reckoned at 1000 ; the specific gravity of sea-water is 1027. Sea-water in the vicinity of land is usually less salt than in the deep ocean ; probably owing to the drainage of the land, and the influx of rivers. For the same reason, branch or inland seas are ordinarily less salt than the ocean. Thus, the waters of the *Baltic Sea* into which numerous important rivers pour their streams, are much less salt than those of the ocean.

The *Mediterranean Sea* forms an exception to the general rule of the inferior saltness of branch or inland seas, the waters of that sea being found to contain a larger proportion of saline matter than those of the Atlantic Ocean. This peculiarity is supposed to be attributable to the proximity of this branch of the ocean to the burning sands of Africa, and also to the parching winds, which passing over this sea after traversing those desert tracts, cause an extraordinary amount of evaporation to [illegible] from its surface.

The *freezing point of water* is affect

contents. The freezing point of fresh water being 32° Fahrenheit, that of sea-water is 28° or 29°. The waters of the ocean therefore require a greater degree of cold than do those of a fresh water lake, to convert them into a solid mass of ice; and it is only in very cold climates that ice is formed in the open sea.

Icebergs, or mountains of ice, though occasionally formed in the sea itself by the accumulation of ice and snow, appear more frequently to consist of glaciers which have been originally formed on the shores, and which becoming detached, and falling into the water, have been floated out to sea. Icebergs are met with in great numbers, about N. lat. 70, but they are sometimes carried by currents into much lower latitudes, having been observed in the northern hemisphere in the parallel of 40°, and in the southern hemisphere in that of 36°. Some icebergs are of enormous size, being two or three hundred feet in height above the water, and probably having about eight times that depth below the surface, and extending sometimes for two miles or more.

Sea water when seen in small quantities seems to be colourless, but when seen in a large mass, its natural *colour* appears to be sky-blue. Since the water acts like a mirror, and reflects the hues of the changing skies, it may often appear to assume different tints, as the sky is clear or cloudless, or according to the position of the sun. Thus at times it will appear of a dull dead colour, at others it will present varied
of purple and green, at others, shine like bur-
old.

In some cases, however, the general colour of the ocean is affected by the nature of its bed, especially if the water be shallow, for yellowish sand mingling its colour with the natural blue tint of the ocean, imparts a greenish hue to the whole mass. If the bed of the sea be red, as is the case in some parts of the Mediterranean, (probably owing to the red coral which abounds in some parts), this red hue combined with the bright blue of the waters of that sea, gives a purple tint. When the water is very clear, the red hue prevails, and the waters appear tinged with that colour. Thus, in the *Bay of Loango*, off the western coast of Africa, the water appears so red that it might be supposed to be mixed with blood.

Sometimes colour is imparted to the ocean by the presence of innumerable minute living creatures. Thus, in the Polar Seas, the water in some parts appears of a green hue, in consequence of its being filled with myriads of yellow *semi-transparent medusæ.* From a similar cause the ocean in other parts appears of a brown colour, in others of a milky white, and in others of a deep red hue.

The *luminosity* or *phosphorescence* of the ocean appears in some instances to be produced by decaying animal and vegetable substances, but in others to arise from the presence of vast numbers of living animals, which, like the glow-worm, have the power of emitting light. Some of these luminous animals shine like liquid silver, and others sparkle like amethysts and emeralds.

VIII. TIDES, WAVES, AND CURRENTS.

The waters of the ocean are in perpetual movement from the effects of *tides*, *winds*, and *currents*.

The waters of the ocean are retained in their bed on the surface of the globe by the *attraction of gravitation*, that is, by the power which has been imparted to all particles of matter to *draw towards them* or *attract other particles of matter*. This power of attraction is great in proportion to the size of any body, a large mass of matter having a much greater power of attraction than a small one; and as the earth is of much greater size than the particles of water on its surface, it attracts them and keeps them in their assigned place. But the sun and moon also possess this power of attraction, and notwithstanding their distance from the waters on the earth's surface, attract and draw them up to a certain elevation in the wide open ocean.

The vast mass of the waters being drawn up by the influence of the moon into a great mountain or curve of water in the wide open sea, forms what is termed the *great primary wave*, or *tidal wave*. When the waters of the ocean are thus drawn up to form this great wave, they necessarily recede from our shores, thus giving rise to *ebb tide* or *low water*. But when the temporary attraction ceases, the waters having been raised above their ordinary level, naturally flow down and spread in all directions, returning to our shores, and forming *flood-tide* or *high-water*.

s *culmination* or raising of the waters into eat wave, takes place twice in twenty-four hours and fifty minutes. The combined influence of the sun and moon at new and full moon augments the size of this wave, and causes the *spring tides* at those periods. The great Atlantic tidal wave arrives first at the western shores of the British isles; it then divides into two branches, the principal of which passes round the coast of Scotland, and travels southward until it reaches the mouth of the Thames, where it encounters the lesser branch, which has swept along the southern shores. High water at the various points along the coasts is dependent on the arrival of this great wave, though some variations are caused by local peculiarities, such as the form of the coast, &c.

The depth of water, or height of the tides, varies at different places, being also much influenced by the form of the land. At Portsmouth and Plymouth, the difference between high and low water is about twelve feet six inches. In the river Thames at London bridge, the average range of the tide is about twenty-two feet; but in the contracted channel of the river Wye at Chepstow, the rise of the tide varies from forty-five to sixty feet.

The waves of the sea which are caused by the action of the wind, and which are called *secondary waves*, or *wind waves*, are of a totally different character from the tidal wave. There is much appearance of confusion in an agitated sea, but in the midst of this apparent disorder, order reigns, and it seems to be in great measure owing to the continual slight shifting of the wind, that waves appear so frequently to cross and intercept each other. The inf
the wind is supposed not to extend to a gr

than forty or fifty feet, the deep sea, though raised in a great mass by the grand tidal movement, being free from agitation. Wind waves at a distance from the shore are comparatively long and low, but as they approach the coast where the water is shallow, they assume a greater curvature, and fall on the beach either in gentle ripples, or in magnificent breakers, according to the depth of the water, and the force of the wind.

The heavy swell which occasionally takes place on the northern coasts of some of the West Indian Islands, called the *ground sea*, is supposed to originate in distant storms of wind in the Atlantic Ocean. The sea, although the air is calm, suddenly rises as if agitated by a heavy gale, and wave follows wave in quick succession, crested with foam, and bursting on the beach with great impetuosity.

Currents in the ocean arise from various causes: they may be produced by long continued gales of wind; by the melting of the Polar ice, or by any cause that may give rise to onward movements of limited portions of the great mass of waters. Some currents of the ocean are permanent: the most remarkable of these are the *Polar currents*, and the *equatorial currents*.

The *Polar currents* are produced by the perpetual movement of the waters from the Polar regions to the equator. In accordance with the laws of mechanics, an accumulation of the waters of the ocean takes place in that part of the globe, which has the greatest velocity of motion: and as the earth
turning on its axis, moves with far greater
at the equator than it does in high latitudes,

the waters consequently flow continually towards that line, thus forming currents in the ocean, moving from the north and south poles to the equator.

This *culmination* or accumulation of the waters of the ocean at the equator, tends to produce the *equatorial currents*, which consist of the continuous progression of the tropical seas in a westerly direction. When the mass of water brought by the Polar currents arrives at the equator—coming as it does from regions where it naturally has less velocity—it does not at once acquire the velocity of the earth at the equator; and since the rotation of the earth is from west to east, this portion of the water lagging behind, forms a stream or current which has an *apparent* motion from east to west, that is to say, apparent as regards the earth, but real in relation to the adjacent land and water. The trade winds, which in this zone blow perpetually in the same direction, lend their aid in maintaining the equatorial current.

An extensive system of currents appears to commence in the Antarctic Ocean. A current of cold water flowing northwards, joins the equatorial current in the Pacific. Entering the Indian Ocean, it maintains its westerly course until it approaches the shores of Africa. Then bending southwards, it rushes through the Mozambique channel, and doubling the Cape of Good Hope, travels northwards until it arrives at the Bight of Benin. This current there joins the equatorial current, and crossing the Atlantic from the coast of Guinea to th
Brazil, it is divided into two branches by t
jecting headland at Cape St. Roque. The

branch flows southwards along the eastern coast of South America, where it meets the Antarctic current to which it owed its commencement.

The northerly branch of this current skirts the shores of Brazil and Guiana, where it receives the waters of the rivers Amazonas and Oronoco. After passing the island of Trinidad, this great oceanic current enters the Gulf of Mexico. The waters there acquire the high temperature of about 88° Fahrenheit. Sweeping round that extensive inland sea, they again pour forth into the Atlantic, forming the most powerful of known currents, called the *Gulf Stream.* On issuing from the Gulf of Mexico this current of warm water rushes with considerable force through the straits of Bahama. Then taking a northward course, it travels along the eastern shores of North America, until it approaches Newfoundland, where it is turned to the eastward, by an opposing cold current which sets in from Baffin's Bay. It now maintains an easterly direction, and crossing the Atlantic, arrives at the Azores in about twenty-eight days. From thence it extends to the Bay of Biscay, and travelling northwards, skirts the western coasts of Europe, sometimes wafting to and depositing on its shores, and also on the western coasts of the British isles, the products of tropical America, and probably imparting to the whole of the Northern Ocean some portion of its more elevated temperature.

IX. THE ATMOSPHERE.

THE Earth is surrounded by its *atmosphere,* which transparent covering, envelopes and revolves with it. This atmosphere is considered to extend to the height of about forty or fifty miles, its height being greater at the equator than at the poles.

The *air*, which expands into and forms this atmosphere, is an elastic fluid consisting of a mixture (not a compound) of *oxygen gas* and *nitrogen* or *azotic gas*, in the regular proportions of twenty-one parts of oxygen to seventy-nine parts of nitrogen. The atmosphere also contains a small quantity of *carbonic acid gas*, and a yet smaller quantity of *ammonia*. *Water* in the form of *vapour*, in which state it is invisible, is also always present in the atmosphere, though the quantity is subject to great variations. All these substances move freely among each other, and are continually changing places; the oxygen being ever ready to perform the office assigned to it of sustaining life and combustion; the carbonic acid, to promote the growth of vegetation; the nitrogen, to perfect the fruits of the earth; and the vapour, to descend to the thirsty ground in the form of showers and dew.

The air being *elastic* is therefore capable of *expansion*, or of spreading in all directions; and also of being compressed into a smaller space; and when compressed, becomes more *dense*, or thicker, and consequently is heavier. And thus, if a closed vessel of any size be filled with compressed air, and another of similar size be filled with air which has not been compressed, the former is found to have more *weight* than the latter, in proportion to the degree of compression.

The consequence of this weight or elasticit
air is, that it is much lighter and thinne

upper regions of the atmosphere than nearer the earth's surface; for at the level of the sea, the air has the weight of the *whole* atmosphere above it to compress it, and give it greater density; but at an elevation of 10,000 feet, the pressure from above being diminished, the air is less dense, and lighter, because its elasticity causes it readily to become compressed near the level of the sea, and to expand in the upper regions of the atmosphere. And hence, air is thinner or more *rarefied* on elevated mountains, than at the level of the sea; the decrease in density being in regular proportion, according to the height above the sea level. In consequence of the air becoming so much thinner or more *rare* at great elevations, travellers who ascend lofty mountains usually find their respiration much affected, and they are sometimes compelled to seek relief by throwing themselves on the ground, which enables them to breathe more freely.

The weight of the atmosphere at the level of the sea, is equal to about *fourteen pounds and a half on every square inch.* This is called the *weight of an atmosphere,* and is balanced by a column of mercury thirty inches in height; but at the elevation of 18,000 feet, it would be balanced by a column only fifteen inches in height, at that of 36,000 by one only seven inches and a half in height, and so on. It is on this principle that the mercurial barometer has been constructed; and since the mercury in the barometer is found (with slight local variations) to stand at the same point at all places at the level of
sea, and to fall in a regular ratio as we ascend
that level, this instrument forms a most useful

standard for measuring the altitude of any place, either mountain, hill, or plain, to which a barometer can be carried. The mercury is considered to fall one degree in about every 950 feet, and therefore it would stand permanently more than half a degree lower, in a barometer at the Telegraph Station on Beachy Head, which is 564 feet above the sea level, than it would in one at the martello tower on the shore near Pevensey. Baron de Humboldt, when he visited Chimborazo in the Andes, found that at the level of the sea near that mountain, the barometer stood at 30°; but at the height to which he ascended, it fell to fourteen inches, eight limes; and accordingly he came to the conclusion that the elevation he had attained was 19,353 feet. Air is subject to variations in its density, even at the same level, being affected by the presence of vapour in the atmosphere, by currents of wind, by electric action, &c., and hence the mercury usually falls at the approach of rain, of wind, or of a thunder-storm, and hence the daily and even hourly fluctuations which take place in the barometer.

The *temperature* of the air likewise diminishes as we ascend above the level of the sea. The rate of decrease does not appear to be absolutely regular, but is considered to be about one degree of Fahrenheit's thermometer for about every 340 feet; and accordingly (though variations occur from local causes) the thermometer generally stands lower in elevated districts, than in those nearer the sea level in the same latitude; and hence it is, that even in hottest regions of the earth, very lofty mounta covered with perpetual ice and snow.

WINDS.

THE aerial currents called *winds* appear to be caused by partial changes in the density of the atmosphere, in great measure arising from the different distribution of heat in various parts of the earth's surface. When air is warmed by the heat of the sun, or any other cause, it becomes less dense, and the space it occupies has therefore more *capacity* or more room to admit an additional portion of air. If an adjacent stratum of air be cooler, it will, on coming in contact with the warmer air, expand and pour into the space occupied by the latter, thus forming a current, or wind. The greater the difference between the temperature of the one portion of air and the other, the greater will be the force with which the cold portion will rush into the space occupied by the warm portion, or, in other terms, the more violent will be the wind. This is well displayed in the violent winds which in some warm regions, almost daily rush down from the adjacent mountains into the plains, as soon as the latter become heated by the mid-day sun.

In the British Isles, and, generally speaking, in temperate climates, the winds are *variable;* but in some parts of the globe they blow with great regularity, and in others are subject to periodical changes

The most remarkable permanent winds are those termed the *trade-winds*. The air at the surface of the sea between the tropics is much warmer than in high northern and southern latitudes; and since air expands, and becomes less dense when heated, the light warm air in intertropical regions perpetually rises from the surface, and its place is as perpetually supplied by the colder air, which glides in from the regions both to the north and south of the tropics. If it were not for the earth's rotation on its axis, these would be merely northerly and southerly winds; but, like the equatorial currents in the ocean, these cool currents of air, coming from regions which have not an equal velocity of rotation with the air at the equator, pause and hang back, and thus these aerial currents acquire a westerly direction, forming permanent north-easterly winds in the northern hemisphere, and south-easterly in the southern. In the immediate vicinity of the equator, where the two aerial currents from the north and south meet, they so completely counteract each other, that a zone, about five degrees and a half in width exists, which is comparatively calm, and free from any prevalence of easterly winds, though subject to storms of thunder and lightning. This zone is called the *variables*. The trade-winds form two great belts, extending on either side of this zone, to north and south latitude 28°. A deviation from their regularity is caused by the proximity of land; and they are less regular in the Pacific than in the Atlantic, and less steady in the north than in the south Atlantic.

While this inter-change of air gives rise to easterly winds in the tropical seas, it at the same time causes *westerly* winds to prevail in higher latitudes. The warm air which has changed places with the cooler northern and southern air, carries with it the velocity belonging to its former situation near the
into regions where the earth's surface

slower pace, and consequently, as this air travels northwards or southwards, it moves at a more rapid pace than that portion of the earth's surface it now occupies, thus giving rise to the *south-westerly* gales so prevalent in our latitude, and to the *north-westerly* gales of the same portion of the southern hemisphere.

The *monsoons*, or periodical winds of the Indian Ocean, appear to owe their origin to the same cause which gives rise to the trade-winds, though they acquire a different character in consequence of the proximity of land. In the southern portion of the Indian Ocean, which is remote from this cause of disturbance, the trade-wind blows with its wonted regularity; but in the seas occupying the region between the eastern coast of Africa on the one side, and the Malayan peninsula and Sumatra on the other, the course of the trade-wind is reversed for half the year. This change occurs from April to October, the sun at that period being vertical north of the equator, and the land in the adjacent regions acquiring in consequence a high temperature, and the air over the sea being cooler than that over the land, a south-west wind prevails. This wind, called the *south-west monsoon*, commences at about three degrees south of the equator, and, passing over the ocean, arrives charged with moisture, and accordingly usually deposits copious supplies of rain in India and some of the adjoining territories. In the remaining half of the year, that is, from October to April, the wind resumes the ordinary north-easterly direction of the trade-wind.

Sea breezes occur in regions bordering on the sea in hot climates. They are produced by causes similar to those which give rise to the south-west monsoon. The surface of the land being more heated during the day than that of the sea, and the air consequently becoming rarefied, the cooler heavier air rushes in from the surface of the sea, thus giving rise to the sea breeze. This usually commences at about ten o'clock in the morning, and continues throughout the day, until about six o'clock in the afternoon, when it gradually sinks away. In some situations the reverse takes place at night, the sea at that time retaining a higher temperature than the adjacent land, and causing a *land breeze* to spring up. This usually commences at about eight o'clock in the evening, and dies away before six in the morning; it is much fainter and less regular than the sea breeze, and also of less common occurrence; for the sea breeze may generally be observed in all warm countries, and even, in sunny weather, on our own shores.

Hurricanes are storms of wind which sweep or whirl round in a regular course, and are at the same time carried onward along the surface of the globe. In the northern hemisphere the whirling motion follows the course of east, north, west, south, to east again; in the southern hemisphere it takes the opposite course. In the Atlantic Ocean, the principal region of hurricanes lies to the eastward of the West Indian Islands. They are of frequent occurrence in the Indian Ocean, at no great distance from the island of Madagascar. The *typhons* of the China seas, and the *ox-eye* of the Cape of Good Hope are also considered to be revolving storms.

The *tornadoes* of the western coast of Africa, the *pamperas* of South America, and the storms call·

arched squalls, appear to be of a different character, and not to possess a revolving motion.

The *sirocco* of Italy and Sicily, and the *solano* of Spain, as also the *simûn* or *simoon* (sometimes called *simoom*) of Arabia, and the *harmattan* of Western Africa, are all winds which owe their origin to the parched and heated surfaces of Africa and Arabia. The principal difference between these winds appears to be, that the sirocco and the solano acquire some moisture in their passage across the Mediterranean Sea, and therefore do not possess that extreme degree of aridity which forms the distinguishing character of the simûn and the harmattan.

WATER in the form of *vapour* is always present in the atmosphere. Warm air is capable of holding suspended a larger quantity of moisture than cold air, and therefore the amount of vapour present in the atmosphere is subject to great variations. If water be exposed to the air, it gradually disappears, finding its way into the atmosphere by the process called *evaporation*. If not exposed to the air, as for instance, if kept in a closely-corked bottle, the quantity will remain undiminished for years; but if we leave the bottle uncorked, the water will ere long be dried up, or evaporated; and if we pour the water into a plate, a larger surface being thus exposed to the air, the process of evaporation will be carried on much more rapidly. Warm air being capable of holding a larger quantity of moisture than cold air, evaporation proceeds more rapidly in warm than in cold weather, and hence a pond, or moist garden mould, will be dried up much more rapidly in summer than in

The fact that warm air is capable of holding a larger quantity of moisture than cold air, accounts for the formation of *dew.* A *cubic* or *four-square* foot of air, at the temperature of 32° (the freezing point), has not capacity for holding more than two grains and a half of moisture, while at the temperature of 70°, it will hold about five grains and three-quarters; and in intermediate proportions between these temperatures. It will therefore be evident that if the air become heated during the day, its capacity for holding vapour being thus increased, evaporation will proceed with greater or less rapidity, and the air will become more or less charged with moisture, according to the nature of the surface on which it rests, or over which it passes, and its own temperature. But when a cold night succeeds to a hot day, the air being no longer capable of holding this watery vapour, it will, as the temperature gradually diminishes, be gradually and gently deposited in the form of dew. Dews will therefore usually be most abundant when cool nights succeed warm days, which in our climate more frequently happens in spring and autumn than in summer and winter. The air usually becomes much colder on clear nights than when the skies are obscured by clouds, and accordingly dew is generally more abundantly deposited on starlight than on cloudy nights.

It is also essential for the copious formation of dew that the ground, or other substance on which it is deposited, should be much cooler than the superincumbent air; for if the ground be warm, it will impart its temperature to the air near its surf
dew will not be formed. The surface of tr

vegetation in general, is much colder than that of bare rocks, or even garden mould, and consequently dew is more abundantly deposited on the herbs of the field and the trees of the forest, than on barren and stony ground.

When the surface of the ground or water, is warmer than the superincumbent air, *mists* and *fogs* are frequently formed. And since water and marshy surfaces cool less rapidly than dry land, mists and fogs are of more common occurrence in low damp situations than in dry elevated districts. They are formed by the *condensation*, or, in other terms, the *transformation of the vapour, into minute drops of water*, which, instead of descending to the earth in the form of dew, remain suspended above the land or the water. A remarkable stationary fog exists off the coast of Newfoundland, which owes its origin to the chilly atmosphere of that region, and the comparative warmth of the adjacent ocean, the temperature of which is apparently raised by the waters of the Gulf stream.

Clouds are formed by the condensation of vapour at considerable, but various elevations in the atmosphere. Vapour is always invisible; clouds therefore are not vapour, but water, and consist of a fine watery powder, the size of each particle being exceedingly minute; and consequently they are so light, that clouds formed of an accumulation of such particles are readily borne forward by the wind. Clouds are
mes suddenly formed, and as suddenly dis-
robably owing to sudden and partial changes
ture, in the region of the atmosphere where

they occur. When a considerable difference of temperature prevails in the aerial currents, or strata of air, which may come in contact, in the atmosphere, a further condensation takes place, and the particles of this fine watery powder unite into drops, and becoming heavier, fall to the earth in the form of *rain*, *hail*, or *snow*. When two strata or currents of air of different temperature, moving with great rapidity in opposite directions, come in contact, a sudden and heavy fall of rain takes place. If one of these strata be very cold, hail may be formed. Snow is formed under the same circumstances as rain, only the formation takes place in cold climates, or at great elevations in the atmosphere.

Clouds are continually varying in their form and appearance, but may be classed under four principal heads:—1, the *cirrus*; 2, the *cumulus*; 3, the *stratus*; 4, the *nimbus*.

1. The *cirrus* is a light fleecy cloud, resembling a lock of hair or a feather.

2. The *cumulus*, or summer cloud, is generally a massive cloud, of a rounded form; sometimes of small size, and sometimes nearly covering the whole sky; and occasionally appearing in the horizon like mountains capped with snow.

3. The *stratus* is a horizontal misty cloud, sometimes observed on fine summer evenings comparatively near the ground, and often crossing the middle regions of mountainous or hilly districts.*

4. The *nimbus*, or *rain-cloud*, has a uniform grey

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* For representations of these three descriptions of clouds see *Frontispiece*.

tint; it is fringed at the edges, when these are displayed, but usually covers the whole sky.

The region of clouds is a zone extending in the atmosphere from about one to four miles above the surface of the globe. The most elevated clouds are the light fleecy clouds which are comprehended under the name of cirrus, and the lowest are those which are called stratus.

The *cirro-cumulus*, *cirro-stratus*, and *cumulo-stratus* are only modifications and combinations of the above four classes of clouds.

The quantity of *rain* that falls in different parts of the earth is very variable; though (since the amount of evaporation is augmented by the higher temperature of the atmosphere) it may be considered as a general rule, that larger quantities of rain fall in low than in high latitudes; and it appears that a gradual decrease in quantity takes place, as we recede from the equator towards the poles. In the island of Tahiti, the annual fall of rain amounts to 150 inches; at Bombay, to 80 inches; in the British Isles, to about 25 inches; at St. Petersburg, to only 17 inches.

Rain is more abundant in the New than in the Old World, which is probably owing to the different configuration of the two great continents. Thus the annual fall of rain in tropical America, amounts to 115 inches, whilst in similar parallels of latitude in the Old World, it does not exceed 76 inches. In the temperate zone of the New World, again, the annual quantity of rain is 37 inches, whilst in the Old World it is only 31½ inches.

In some parts of the earth, extensive tracts exist, here rain is never known to fall, or if at all, only at intervals, and then in small quantities. The rainless districts in the New World include the flat territories of Northern Chili and Peru, some parts of Mexico, and some parts of California. In the Old World, an extensive rainless band extends from the western shores of Africa to the central regions of Asia, including the Great African Desert, Egypt, part of Arabia, and the desert of Cobi. Countries so circumstanced—unless, like Egypt, rendered fertile by the overflowings of a great river—constitute the most arid and desolate regions of the earth.

The quantity of rain which falls in any region depends greatly on local causes, such as the variations of the surface, the prevailing winds, the proximity of the ocean, &c. Rain is usually more copiously deposited in mountainous and well-wooded islands than in any other description of surface, of which the Island of Tahiti affords a striking example; for this beautiful island, surrounded as it is by the waters of the ocean, covered with luxuriant vegetation, and containing mountains rising to the height of 10,000 feet above the level of the sea, possesses every requisite condition for the copious deposition of rain. The warmth of the air causes a large amount of evaporation to take place from the ocean which surrounds it on all sides, and this vapour becomes condensed by the cool surface presented by its elevated and richly wooded mountains and hills; and hence the extraordinary quantity of rain in that island. The rainless district of Peru, on the other hand, though it borders on the Pacific Ocean, is flat and nearly destitute of trees, whilst on the inland side, the Andes rise abruptly to a great elev

DISTRIBUTION OF RAIN OVER THE EARTH. TRADE WINDS & MONSOONS.

the consequence of which is, that the moisture brought by the westerly winds from the ocean, does not become condensed in its passage across the hot surface of the flat districts of Peru, and therefore rain scarcely, if ever, falls in that region, but an abundant deposition takes place on the elevated mountains in the interior. And thus again, if elevated hills border on the ocean in any district, whilst the interior consists of flat plains, the moisture usually is deposited on the elevated land, and the interior tracts receive small supplies of rain; such is the case with the rainless portion of Arabia.

The annual fall of rain in the British Isles, amounts, as has been stated, to about 25 inches; but the quantity differs greatly in the eastern and western districts. The winds sweeping over the expanse of the Atlantic Ocean, arrive charged with abundance of moisture, but deposit a considerable portion before they reach the inland and eastern districts. Thus, the amount of rain that falls annually at Glasgow is nearly eight inches more than at Edinburgh. The number of rainy days in England, is estimated at about 154 in the year, and on the western coast of Ireland, at no less than 208. The amount of rain does not, however, necessarily depend on the number of rainy days, for though the amount of rain within the tropics is so much greater, the number of rainy days does not usually exceed 78 or 80.

In intertropical regions the rains follow the sun; that is, when he is north of the equator, the rains prevail in the northern tropic, and when he is south of that line, in the southern; this forms t
and *dry seasons*, to which countries so si

subject. This does not, however, apply to the whole of the intertropical regions, for in a zone extending from the fifth to the tenth degree of latitude on each side of the equator, there are two rainy and two dry seasons. In the narrow belt, called the *variables*, which is situated between the regions of the north and south trade-winds, rain is almost incessant, accompanied by thunder and lightning. In intertropical countries, during the rainy season, the rain pours down in such torrents, that a larger quantity sometimes falls in a few hours than in a whole month in the British Isles.

Beyond the tropics some countries possess rainy and dry seasons, and, generally speaking, greater abundance of rain falls at particular periods of the year, though to the north of the 45th parallel of latitude, the rains are usually variable, of which we meet with an example in the British Isles.

X. CLIMATE.

The term *climate* is used to express the combination of temperature and moisture which prevails at any particular place, or, in more familiar terms, the *prevailing weather*.

The most prominent causes of diversity of climate are, the *heat of the sun*, the *relative position of land and water*, and the *elevation of land above the level of the sea*. To these may be added, as producing considerable, though less marked effects, the *nature of the soil*, the *prevailing winds*, the *position of* *ain ranges*, and the *currents of the ocean*.

un is the grand agent in diffusing heat over the surface of the globe, the temperature of any part, being almost wholly dependent on its exposure to his rays. Whilst the sun is above the horizon of any place, that place is receiving heat; and when the sun is below the horizon, it is parting with heat by the process called *radiation*, that is, the emission of heat through the atmosphere into the regions of space. Whenever, therefore, the sun remains more than twelve hours out of the twenty-four, above the horizon of any place, and consequently less than twelve hours below, the general temperature of that place will be above average; and when the reverse occurs, it will be below average.

In consequence of the daily rotation of the earth, successive portions of its surface are presented to the sun's rays; and owing to the inclination, or slanting position of the earth in its orbit, the northern and southern hemispheres are brought alternately, more directly under the solar influence, and thus by this admirable and beneficial arrangement, the high temperature of the tropical zone is moderated, and heat more generally diffused over the earth's surface. The power of the sun's rays is great, in proportion to the *vertical* or *upright direction* in which they strike the earth; and if the sun's rays had been permanently vertical in equatorial regions, the heat in those parts of the earth would have been greatly more intense, and, on the other hand, the yet more slanting rays of the sun in higher latitudes, would not have possessed sufficient power to ripen the fruits of the earth in the present temperate zones, nor should we have enjoyed the grateful ch
spring, summer, autumn, and winter.

We have seen that the earth has been artificially divided into five zones; the torrid, the two temperate, and the two frigid zones. If the temperature of any place depended solely on the heat of the sun, this might convey a tolerably accurate view of the respective climates in those divisions of the globe; but it is so greatly modified by other circumstances, that considerable differences prevail in countries situated in the same parallels of latitude.

The *relative position of land and water* forms one leading cause of the diversity of climate. The waters of the ocean are of very equal temperature, widely differing in this respect from the surface of the dry land. This arises from the waters of the ocean always preserving a nearly uniform level, from their tardiness to become heated (because water is a bad conductor of heat), and from their not possessing the same radiating power as dry land, so that they are not subject to be cooled down during the absence of the sun. The ocean, therefore, has a tendency to moderate both heat and cold wherever its influence extends. Thus, when a cold wind passes over the sea, it becomes warmed, and the rigor of winter will be moderated. A hot wind, on the contrary, becomes cooled in passing over the sea, and the summer temperature of the adjacent regions will be lowered. And thus we find that the climate of islands, and countries bordering on the sea, usually differs considerably from that of the interior of continents, the former generally experiencing milder winters and more temperate summers than the latter. Such are said to possess an *insular climate.*

Thus, the British Isles possess an insular climate. But when any region experiences great severity of cold in winter, and at the same time a considerable degree of heat in summer, it is said to possess an *excessive climate.* Pekin forms a striking instance of an excessive climate; the average winter temperature being 23°, and the average summer temperature 79°.

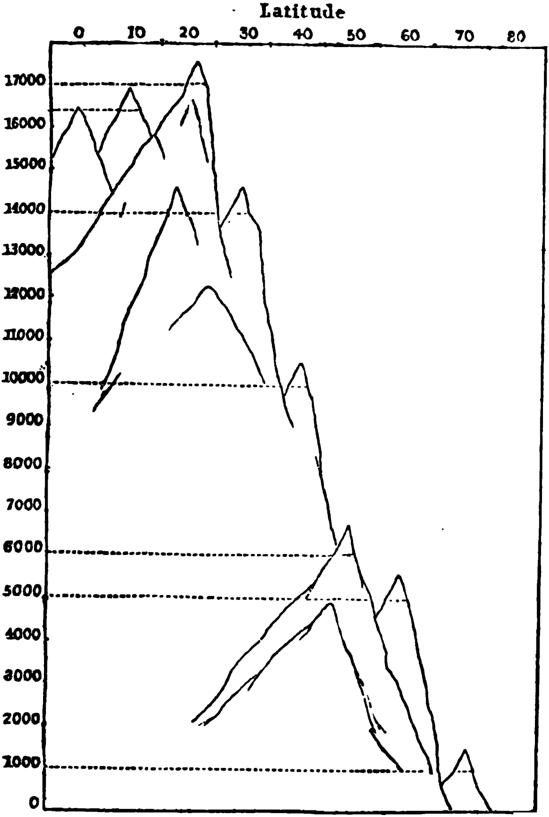
The effect produced on climate by the relative position of land and water, is exhibited on a large scale in the temperate zones of the northern and southern hemispheres. The space occupied by the waters of the ocean in the southern hemisphere, is far greater than in the northern, and consequently a much more *even* temperature prevails in the regions occupying that portion of the globe, than in those in the northern hemisphere.

The *elevation of land above the level of the sea* forms another leading cause of the diversity of climate. A gradual decrease in temperature takes place as we ascend above the level of the sea, until we attain a point where perpetual congelation takes place. This line, which is called the *snow-line,* or *line of perpetual snow,* varies in different latitudes, and sometimes, owing to the different causes which may give rise to diversity of climate, the height of the snow-line differs at places in similar latitudes. As a general rule, however, it may be considered, that a gradual decrease in the elevation of the snow-line above the level of the sea, takes place as we recede from the equator towards the poles. The height of the snow-line within the tropics from 16,000 to 17,000 feet above the level of the sea; and (in the northern hemisphere) this line descends to the very level of the sea at about latitude 80°.

The annexed tabular view of the snow-line in different latitudes, may convey a general idea of the limits of perpetual congelation in the northern hemisphere.

It will be perceived that the snow-line is higher at the distance of twenty degrees from the equator, than at the equator itself. This is explained by the circumstance, that the sun at the equator is never more than twelve hours above the horizon; whereas, near the tropics, the longest days are thirteen hours and a half in length; and as the sun at that period of the year is vertical, or nearly so, in that portion of the globe, the *summer* heat, on which the line of perpetual snow depends, is greater than immediately under the equator.

The gradual decrease of temperature which takes place, according to the elevation of land above the level of the sea, has a very beneficial effect in diversifying the climates over the earth's surface, and in adapting it for the growth and sustenance, of an almost endless variety of plants and animals. In intertropical regions, districts which are situated near the level of the sea possess an extremely high temperature, and unless furnished with most copious supplies of rain, present a highly arid and parched aspect, like Peru; but, on the contrary, if rain falls abundantly, they are covered with the most luxuriant vegetation, like the fertile lowlands of Guiana. At of 3000 or 4000 feet, the heat becomes



TABULAR VIEW OF THE SNOW LINE IN DIFFERENT LATIT
IN THE NORTHERN HEMISPHERE.

less intense, and a change takes place in the productions of the soil. At that of 7000 or 8000, the vegetation, and in great measure the climate, resembles that of temperate countries. At still greater elevations, the climate and plants are similar to those of arctic regions; and at length the line of perpetual congelation is reached, where nothing meets the eye, but bare rocks and accumulations of ice and snow.

In warm latitudes, the snow-line is found to be higher on mountains which enclose or border on elevated table lands, than on isolated mountains, or on such as rise precipitously from low plains. This appears to be caused by radiation from the elevated plains; for the latter having become heated during the day, radiate or part with this heat during the absence of the sun, and thus tend to maintain the temperature of the mountains in their vicinity during the night, whereas, isolated mountains, being surrounded by the atmosphere, part with, instead of receiving heat, during the sun's absence.

The Himalaya Mountains afford a striking example of the effect thus produced by an elevated tableland. On the *southern* side of that mighty range, in N. lat. 30, the mountains rise directly from a flat country, not more than 1000 feet above the level of the sea, covered with a close jungle, which tends to cool the superincumbent air; and on this side of the mountains the height of the snow-line does not exceed 12,000 or 13,000 feet. On the northern side of the same vast mountain the elevated table-land of Tibet extends, rising to the height of 15,000 feet above the level of the sea; and in the vicinity of this great plain, the snow-line reaches the height of 17,000 feet above the level of the sea. In very cold climates the reverse takes place; for *cold* is radiated from ice-covered table-lands, and they therefore have a tendency to lower the temperature of mountains which are situated near them; and the temperature of isolated mountains in icy regions, is sometimes found to be higher than that of the plains at their base.

The *nature of the soil* produces some effect on the climate of any region. *Sandy soils* are subject to become rapidly and intensely heated, and when the sun's rays are withdrawn, they rapidly radiate and part with the heat they have acquired, thus increasing the general temperature of the surrounding districts. *Clayey soils,* on the other hand, become slowly heated, and as slowly part with heat. *Swampy ground* chills the air, and *extensive forests* produce a similar effect; and thus, cultivation not unfrequently causes a change in the climate of a country; for the draining of marshes and the clearing of dense forests, may raise the winter temperature of a cold country, as has been effected in some parts of North America, whilst irrigation and the culture of trees may tend to improve and moderate the climate of hot dry lands, as has been experienced, though hitherto on a small scale, in some parts of California.

The *prevailing winds* produce considerable effects on the climate of any region. Countries where the prevailing winds sweep across a wide ex
ocean, are not subject to extremes of hea

Thus, the climate of the British Isles is moderated, because the most prevalent winds pass over the Atlantic Ocean. Winds which traverse large tracts of land, vary in character according to the nature of the surface over which they pass. Thus, the easterly winds of Great Britain cross the vast lowland of Europe, before arriving at our shores. In the spring, after the melting of the snows, the surface of the European plains is damp and cold, and consequently the March winds in this island are usually bleak and chilly. But in the autumn, those plains are dry and sandy, and having become heated by the summer sun, impart their higher temperature to the winds which pass over them, and consequently, our autumnal easterly winds generally bring with them a warm temperature.

The *position of mountain ranges* also produces considerable effect on the climate of any region, especially when elevated ridges extend from east to west, and thus either form a screen from the north, or leave a country unsheltered in that direction. Thus, the Carpathian Mountains screen Hungary from the cold blasts of the north, and consequently that territory enjoys a remarkably mild climate; whilst Poland, which is situated to the north of that range, and therefore unprotected from those piercing winds, suffers from a very cold and humid climate.

The *currents of the ocean* form very influential causes of the diversity of climate. The polar currents, as we have already seen, carry towards the [illegible], not only vast streams of cool water, but also floating masses of ice, which tend in a great measure to lower the temperature of the regions near which their course extends. The Gulf stream, on the other hand, traverses the Atlantic Ocean, carrying with it a high temperature, which it imparts to Western Europe, and in all probability to the whole of the Northern Ocean.

The waters of the Gulf stream bear with them from the Gulf of Mexico, large quantities of a species of sea-weed called *sargasso;* this accumulates (probably owing to the meeting of some currents) in a portion of the ocean lying between the 33rd and 35th parallels of north latitude, and covers an area extending about 2000 miles from east to west, and 350 from north to south. The water in this tract of the ocean is nearly stagnant, and being continually supplied with fresh streams of water which have become heated in the Gulf of Mexico, its temperature is maintained to the height of from 7° to 10° above that of the Atlantic in the same latitude. This is called the *Sea of Sargasso,* or the *Recipient of the Gulf stream,* and there appears reason to conclude, that this mass of warm water materially affects the climate of the regions to which its influence extends, both in Europe and North America.

The causes which produce diversity of climate being so various, great difference of temperature is found to prevail in similar parallels of latitude, and no rule can be laid down relative to the climates on the earth's surface. It may, however, be considered that, generally speaking, the eastern districts of the Old and New Continents possess more climates than the western districts of either; that the climate in the interior of continents is more excessive than either; and that islands have a more equable, or less variable temperature than large masses of land.

In intertropical regions, comparatively little variation occurs in the temperature throughout the year; in some places there being scarcely more than four degrees between the average temperature of the warmest month, and that of the coldest month. In temperate zones, the difference is usually much greater. Thus, in London, the *mean* summer temperature (that is, the *mean* or *medium* between the highest and lowest, as well as all the varying temperatures, observed at particular hours on the thermometer during the summer months) is about 63°; and the mean winter temperature is about 39½°; the difference between the mean summer and winter temperature being twenty-three degrees and a half. At New York, the mean summer temperature is about 71°, and the mean winter about 30°, making a difference of forty-one degrees.

With the view of ascertaining the general distribution of heat over the surface of the globe, observations relative to the mean annual temperature of various portions of the earth have been made, and lines called *isothermal lines*, or *lines of equal temperature*, are traced on the globe, indicating the various points on the earth's surface where the same *mean annual temperature* has been observed to prevail. ines do not coincide with the equator, or with els of latitude, places possessing the same annual temperature, being often situated in widely different parallels of latitude. Thus, London and New York possess very nearly the same mean annual temperature, that of 51°; but London is situated about eleven degrees further north than New York, and, as we have just seen, the summer and winter temperature of the two cities differs considerably. It is therefore evident, that though these isothermal lines convey a general idea of the *distribution of heat over the earth's surface*, they do not determine the *climates* of the regions where the observations have been made. Lines indicating the mean summer and mean winter temperatures, called *isotheral* and *isochimenal lines*, when these shall have been carried out on the surface of the globe, may tend more fully to accomplish this object.

The line of *highest temperature*, which is nearly 83°, takes its course generally to the north of the equator, crossing the Isthmus of Panama, and passing through Africa at about the 11th parallel of latitude. The interior of the latter region is considered as the hottest portion of the earth.

XI. ELECTRICITY AND MAGNETISM.

Electricity produces an infinity of changes in the natural world. It may be artificially elicited or called forth, by friction, and then it is termed *ordinary electricity;* or by the contact of certain substances. and the action attendant on this contact, and is called *voltaic electricity.*

All substances are supposed to contain a certain portion of electricity, and if by friction, or any other means, any substance acquires more electrical action than it would naturally possess, it is said to be *positively electrified;* and if, on the other hand, there appears to be less electrical excitement than it would possess in its natural state, it is said to be *negatively electrified.* Substances when positively electrified, *attract* or *draw towards them,* other substances which are in a state of negative electricity, or even those which are in a natural state; but will *repel* or *force from them,* substances which are positively electrified.

The electrical state of substances is easily disturbed, and even without actual contact, any substance in a state of positive electricity may produce negative electricity in a substance near it. The sudden contact of bodies in an opposite state of electricity is attended with vivid light, called the electric spark, and accompanied by an explosion and shock. This is exhibited on a splendid but awful scale, in the lightning's flash and the thunder clap.

The *earth* is considered to be always in a state of *positive electricity,* the *air,* when pure, to be in one of *negative electricity.* Atmospheric air, however, is subject to incessant variations, both as to the character and degree of its electrical excitement, for it is liable to be affected by the evaporation and condensation of moisture, by the various chemical processes which are continually carried on in the
ld, &c., and thus the *electrical equilibrium*
here, or its natural electrical state, is

subject to be disturbed. This equilibrium will be restored when an explosion has taken place, and hence it is that in peculiar states of the atmosphere, thunder storms act a beneficial part in restoring the air to a healthy condition, or, in other terms, restoring the electrical equilibrium.

The intensity of electricity is greater during the day than at night, and also in summer than in winter; and is considered to diminish from the equator to the poles.

Electricity is perpetually effecting great changes in the earth's crust; not perhaps so much in its loud and fearful displays, which are evident to man, as in its unseen quiet operations; in very many instances unquestionably acting on the principle of *voltaic electricity*, the electrical action in such cases being produced by long-continued electrical currents. To this powerful agent may be attributed the formation of the *gems* and *crystals*, which excite our admiration from their brilliancy and richness of colour; and also, in all probability, many of the metallic deposits, which occur in the crevices and fissures of the earth's crust.

Terrestrial magnetism may be regarded as a peculiar exhibition or state of electricity, and may be considered under two heads—viz., *magnetic direction*, and *magnetic intensity*.

The magnetic power of the *loadstone* to attract iron or steel is well known: if a bar of iron or steel, be subjected to a continued current or stream of electricity, or even be allowed to remain in contact with the earth in a vertical, or upright position for a lengthened period, as old iron railings may have it acquires this magnetic power, or becomes *magnetized.*

If a nicely-balanced *bar* or *needle* of *magnetized steel* or *iron,* be suspended from its middle by a piece of untwisted silk, free to move in all directions, both horizontally and vertically, it will turn itself to one particular position, and if disturbed, it will invariably return to the same position, pointing downwards to the earth at a particular angle, and also in a particular northward and southward direction. This is called the *magnetic direction* of the needle. If placed on a pivot, in a box or case, so as to confine it in a horizontal position, it will be found to assume the same regular northward and southward direction; not *due* north and south, but northward and southward. At one period the magnetic needle was supposed to point so truly to the poles of the earth, that the phrase, "true as the needle to the pole," has become a proverbial expression; and hence the north and south ends of magnets were termed their *north* and *south poles;* and in fact it appears that in the year 1659, the needle actually pointed thus truly in London.

It is on the above principle that the mariner's compass has been constructed, which was supposed to point invariably due north and south. It is now well known, not only that the magnetic needle does not point *due* north and south in all parts of the globe, but that it does not permanently maintain the same direction at the same places. Thus we have seen that in the year 1659 the needle pointed due north in London; previously to that period it had pointed to *astward* of north; and subsequently it has varied or changed its position so much, that it now points about 24° to the *westward* of north. This deviation from the north is called the *variation* or *declination* of the needle.

The *mariner's compass* is an instrument of incalculable value to navigators; and since the magnetic needle does not maintain the same direction in all parts of the world, it is highly important that they should be acquainted with its variations. To facilitate this, careful observations have been made, and lines are marked on charts and globes, indicating the local variations of the compass needle. These are called *lines of eastward or westward variation;* or, (where the needle points due north) *lines of no variation.* These lines being subject to some alteration in the lapse of years, renewed observations are required from time to time, to aid the mariner in his transit across the ocean.

We have seen that the magnetic needle, if freely suspended, does not settle itself in a direction parallel with the horizon, but *dips* or *inclines downwards;* this is called its *dip* or *inclination.* This dip or inclination of the magnetic needle, like its declination, differs in different parts of the earth's surface, and, like that, has undergone considerable changes in its direction.

The observation of navigators shows that there is a line encircling the earth, at every point of which the needle will take a true horizontal position. This is called the *magnetic equator.* It appears to cross the terrestrial equator at four points, but [illegible] and position are continually varying.

mignionette, the laburnum, oak, &c., all of which belong to this class. The number *five* generally prevails in the division of the parts of the flowers in this class. This class includes a large proportion of the trees of the forest, and also most of the flowering shrubs and herbs. The oak, pine, elm, ash, beech, poplar, chesnut, walnut, &c., belong to this class, as do also the rose, mallow, heath, daisy, pea, cabbage, &c. &c.

The number of different kinds of *exogens*, or *exogenous plants*, is far greater than that of *endogens*, or *endogenous plants*. In tropical regions the proportion is about four to one, and in temperate zones about six exogens to one endogen. In the arctic regions the proportion is not above two to one, but in the latter regions, forest trees are few in number and dwarfish in growth; and cryptogamic plants are very abundant.

Some plants are *perennial*, that is, live for a greater or less term of years, some species attaining a very great age. The oak appears to arrive at perfection at about the age of sixty years, but lives for a much longer term; yew trees are much longer lived than the oak. Some plants are *annual*, springing up, producing flowers and fruit, and decaying in one short season. Other plants are *biennial*, usually only sending forth stems and leaves in the first year, and perfecting their flowers and fruit in the following season.

Some plants are *deciduous*, or cast their leaves in the autumn, and renew them in the spring; others *ergreen*, and never destitute of foliage. The te zone may be considered as more especially the region of deciduous trees. The never-ceasing energy with which vegetation proceeds in intertropical regions, imparts to the plants of those climates a luxuriance unknown in the temperate zone, and at no time are the trees bare of leaves; a screen being thus afforded to the inhabitants of those regions, at all seasons of the year, from the scorching rays of the sun. The evergreen trees of the cold regions of the earth, are of a totally different character, consisting chiefly of pine and fir trees, whose needle-shaped leaves are adapted to withstand the rigours of a northern winter, and whose thick foliage, often sustaining a mass of snow, forms a shelter both to man and to animals, from the severe and long-continued cold.

Plants derive their nourishment from the atmosphere and from the earth. The leaves of plants constantly imbibe both moisture and carbonic acid gas from the atmosphere, during the hours of daylight, and more particularly of bright sunlight. Carbonic acid consists of a compound of carbon and oxygen; this carbonic acid gas the green parts of plants have the power of *decomposing*, or of *separating into its two component parts* of carbon and oxygen; the carbon enters into their composition, and the oxygen is returned pure into the atmosphere. As plants possess less energy in the shade, or in dark gloomy weather, they have not, under such circumstances, power to decompose the whole amount of carbonic acid they imbibe, and a certain portion of carbonic acid as well as of oxygen is given out by the leaves. At night they no longer e
oxygen, but, on the contrary, return the c

almost unchanged into the atmosphere. Carbonic acid gas is deleterious both to man and animals, and hence it is that plants in our apartments, if placed in the full light, are healthful, but are likely to prove injurious at night.

The *carbon* thus derived from the atmosphere enters into the composition of plants, and forms their solid parts; they also imbibe *ammonia* from the atmosphere, the latter (which is a compound of nitrogen and hydrogen) appearing to be essential for the perfection of the flowers and fruit. The roots suck up both carbonic acid and ammonia, as well as moisture, from the soil; from whence they also derive *potash*, *soda*, *lime*, *silica* or *flint*, and various other substances, which give to vegetables their hardness. Thus, to bring wheat to perfection, it requires a supply of moisture and carbonic acid to promote the growth of the blade; silica to give the culm or stem its hardness and firmness; and ammonia or nitrogen for the nourishment of the grain; and, above all, the sun's rays to give energy to the whole, for wheat will not succeed in regions where the *mean summer* temperature is below 57° or 58°.

Intertropical America is no less distinguished for the splendour and luxuriance of its vegetable productions, than for their *variety*, the number of plants which are natives of that portion of the globe, being more than double that of those which are *indigenous* to, or natives of Europe. The whole of Asia and its islands possess a smaller number than Europe. Oceanica, including Australia, New Zealand, and the s in the Pacific Ocean, less than Asia; and Africa (as far as hitherto explored) a smaller number than any other portion of the globe of similar extent.

Some species of plants are met with only in very limited districts, to which they appear to be wholly confined; thus the Irish yew appears to grow naturally, nowhere except in Ireland. Other plants have a much wider range; thus the Scotch fir is met with not only in Scotland, but in various other regions possessing a nearly similar climate. It however appears that, generally speaking, particular kinds of plants form the *prevailing* vegetation, in certain portions of the earth's surface, and accordingly botanists have attempted to arrange it into *botanical regions*, each region being named from the *preponderance* of certain plants. Thus the southern portion of the United States is called the *Region of Magnolias*, because that plant grows in remarkable abundance, and to a splendid size in those regions. The lowlands of Mexico and of some adjacent countries, are called the *Region of Cacti*, from the preponderance in those districts of the cactus tribe of plants.

We have seen that a similarity exists between the temperature of land near the level of the sea in high northerly and southerly latitudes, and that of elevated mountains in hot climates. We also find that a remarkable correspondence occurs between the plants which are natives of regions bordering on perpetual snow—and therefore possessing nearly similar climates—however remote they may be from each other, or however different may be their elevati above the level of the sea. The temperature o middle region of mountains in equatorial usually approaches to that of temperate zones, and the plants growing in those respective regions usually bear much resemblance, though they by no means exhibit so great a similarity as those of frigid regions. The *flora*, or assemblage of plants, in equatorial regions, may be considered as peculiar to those portions of the globe.

Baron de Humboldt divides the surface of the earth into eight zones of vegetation, which are named from the prevailing plants of each zone or region.

1. The *equatorial zone*, or *region of palms and bananas*, which extends to about 15° on each side of the equator, and corresponds to about 3000 feet above the level of the sea under the equator. The vegetation in this region consists of dense forests, which never lose their foliage, and to which the preponderance of palm trees imparts a peculiar character. The luxuriant and lofty trees are interlaced and overtopped by gigantic creeping plants, or covered with singularly-formed *orchidaceous* plants, which derive their sustenance from the atmosphere.

2. The *tropical zone*, or *region of tree-ferns and figs*, extending from about latitude 15° to the tropics. Tree-ferns do not arrive at their greatest perfection at the level of the sea under the equator, their range being from about 1300 feet to 5000 feet above the level of the sea. In the South Pacific Ocean, owing to the more equable climate of that portion of the globe, tree-ferns succeed in much higher latitudes, these trees being very prevalent in the forests of land.

3. The *sub-tropical zone*, or *region of laurels and myrtles:* from the tropics to about 34°.

4. The *warm temperate zone*, or *region of evergreen trees:* from 34° to 45°.

5. The *cold temperate zone*, or *region of deciduous trees:* from 45° to 58°.

6. The *subarctic zone*, or *region of pines:* from 58° to the arctic circle.

7. The *arctic zone*, or *region of andromedas* and *alpine rhododendrons:* from the arctic circle to 72°.

8. The *polar zone*, or *region of alpine plants* (gentian, ranunculus, &c.:) from 72° to the farthest limits of vegetation. In this region lichens and mosses are very numerous. Alpine plants grow under the equator to the elevation of 12,000 or 13,000 feet above the level of the sea. Owing to local peculiarities, some species grow at still greater elevations in the Himalaya mountains, springing up as the snow melts, at the height of more than 16,000 feet.

In the temperate climate of Europe the effects produced by elevation above the sea level, though less striking than in equatorial regions, are nevertheless of great importance. Thus,* in the lowlands of Italy and Sicily, and the south of Spain, palms and other plants of the warm regions of the earth come to perfection; these are succeeded by the orange, the fig, and the olive; the two latter of which thrive in the southern valleys of Switzerland, but do not succeed beyond 1000 feet above the level of the sea. In the latter region, the vine may be successfully cultivated to the elevation of 1600 feet; the walnut to 2400 feet; and the chesnut to nearly 3000 feet. The range of the oak, ash, and maple, extends to about 3800 feet; that of the larch to about 6000 feet; of the pine to 6800 feet; and of the spruce fir to 7400 feet, which is about 2000 feet below the snow-line in that region. Beyond the region of trees, heath and furze, interspersed with some low shrubs, form the principal occupants of the soil, though abundance of valuable alpine grass is met with in some parts. At still greater elevations, lichens and mosses grow in the crevices of the otherwise bare rocks; and, even beyond the line of perpetual congelation, the singular vegetable production called the *palmella nivalis*, or *red snow*, which occurs abundantly in the arctic regions, is occasionally found amid the perpetual snow of Mont Blanc.

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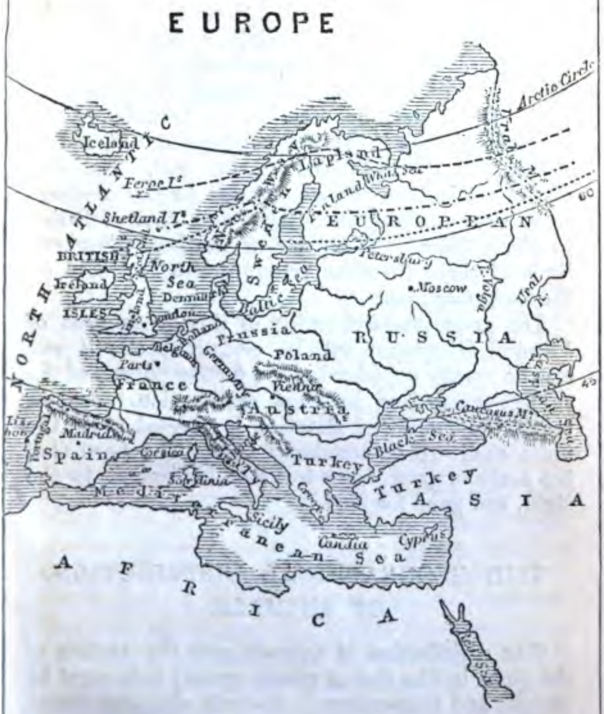
* *See* Frontispiece.

An acquaintance with the various zones, and elevations above the sea-level, at which plants of utility to man will succeed, is of extreme importance to all settlers in newly-colonized countries; for, as it would be a vain attempt to introduce into this island, plants adapted to flourish only in hot climates, so would it lead to disappointment were we to cultivate in intertropical regions, such as will only thrive in temperate zones, in cold regions, such as require a high summer temperature, or in dry regions, such as require abundance of moisture. Now, wheat will not succeed at or near the level of the sea in intertropical regions, nor will it come to perfection in climates where the summer temperature is below 57° Fahrenheit. It, however, may be cultivated with great even under the equator, between the eleva-



NORTHERN LIMITS OF THE GROWTH OF WHEAT, OATS, & BARLEY, IN EUROPE.

·········· Wheat — · — · — Oats — — — — Barley tions of 4500 and 10,000 feet above the level of the sea. Its northern or polar limits in North America have scarcely yet been determined; its successful cultivation does not extend beyond N. lat. 58° in the British isles, but reaches to latitude 64° in Norway, though in Sweden not beyond 62°, and in Russia not much beyond N. lat. 60°. The successful cultivation of oats extends to the northern extremity of the British isles, and that of barley to Faroe isles. The polar or northern European limit of these three important grains is traced on the foregoing map.

The great practical utility of this department of Physical Geography will be evident to all; it will also be readily conceived, that a further pursuit of the subject must lead to great gratification. And in truth, the more our attention is directed to it, the more shall we be convinced that "The Lord God has made to grow every tree that is pleasant to the sight, and good for food."

XIII. GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

THE distribution of animals over the surface of the globe is, like that of plants, greatly influenced by climate and temperature. Animals also, like plants, belong to particular regions, or have their natural *stations* and *habitations*, though, since a considerable number of animals possess the power of transporting selves from one region to another, these cannot cases be so determinately fixed.

The animal kingdom has been arranged in four great divisions: 1, *vertebrata,* or vertebrated animals; 2, *mollusca,* or molluscous animals; 3, *articulata,* or articulated animals; and 4, *radiata,* or radiated animals.

The *vertebrated animals* are so named, from the bones of the neck, which are called *vertebræ.* Animals belonging to this division all possess a skull and a back bone; they have organs of sight, hearing, smell, and taste; and have never more than four limbs, though in some classes of animals these limbs are not so perfectly developed as in others. This division includes *man, quadrupeds, birds, serpents, frogs, tortoises, crocodiles,* and such *fish* as *cod, herrings,* &c., all of which have a bony skeleton.

This division of the animal kingdom is subdivided into four classes: 1, *mammalia,* or animals which suckle their young, such as the cow, &c.; 2, *birds;* 3, *reptiles,* such as the serpent, crocodile, &c.; 4, *fish,* that is, such fish as possess a bony skeleton.

The *molluscous animals* are so named from *mollis,* "soft," because their bodies are soft, and are without a bony skeleton. Many molluscs have shells forming a covering and defence for their soft bodies; the *oyster, snail,* &c., possess these protecting shells; others are destitute of this covering; of this we find instances in the common garden *slug,* the *cuttle-fish,* &c.

The articulated animals are so named from *articulus,* "a little joint," on account of their peculiar formation, which consists of a head and successive portions, *jointed* together. To this division belon the *insect tribes,* the *earthworm, crustaceous anim* or *crustacea,* (such as *lobsters, crabs, shrimps,* &c.) Some articulated animals have jointed limbs attached to the side of the body, like the *fly, centipedes, lobster,* &c.

The *radiated animals* form the fourth great division of the animal world. They are called *radiated,* because in the greater number of the animals belonging to this division, the organs of motion and sense are considered to radiate from a common centre, like the *petals* or flower-leaves of a daisy or anemone. To this division belong the *coral animal,* the *sea-anemone,* &c. Animals of this division are also termed *zoophytes,* from *zo-on* "life," and *phyton,* "a plant," because, though in fact they are living creatures, they bear a great resemblance to plants in their structure.

The radiata rank as the lowest in the scale of living creatures; the vertebrata as the superior or most perfect; and among the latter, the subdivision or class mammalia, or mammiferous animals, hold the highest place.

When animals are *identical* in their anatomical structure, they are considered to belong to the same *species.* When two or more kinds of animals are very nearly alike in their structure, though with some differences, they are considered to belong to the same *genus* (plural *genera*). When the differences are greater, they are arranged into a group, called an *order.* And when only a few points of resemblance can be traced, they are regarded as belonging to the me *class.* Thus, the dog belongs to the *class* malia, to the *order* carnivora, to the *genus* and to the *species* dog. Among some species, we also meet with *varieties ;* thus the varieties of the dog are, the mastiff, greyhound, terrier, &c.

The same species of animals are not met with in all parts of the world, and even some genera are found to be peculiar to particular regions. Thus, the *royal lion is* met with only in Africa, the Asiatic lion being of a different species, and of a smaller size. The tiger is peculiar to Asia, and some of the Asiatic islands ; the giraffe to Africa ; the elephant is found in Africa, and in some parts of Asia, but the African and Asiatic elephants are of different species.

The animals of the Old World generally differ in species from those of the New World. Thus, besides those we have already enumerated, the ape and baboon, the hyæna, panther, rhinoceros, hippopotamus, horse, ass, camel, buffalo, crocodile, python, &c., are all inhabitants of the Old World.

The puma (sometimes erroneously called the American lion,) the jaguar, the sloth, armadillo, bison, llama, alligator or cayman, boa constrictor, rattlesnake, &c., are all peculiar to the New World.

In the most northerly parts of both continents alone, are the same species of animals found ; thus, the Polar bear and the Arctic fox inhabit the whole of the icy regions, extending from Spitzbergen and Siberia to Arctic America ; these animals being capable of enduring the severe cold of those high latitudes, and of traversing the frozen surface from one continent to the other.

The *fauna,* or group of animals which are met with in Australia, are mostly peculiar to that re and include some very singular forms. Amon are the various species of opossum and k the ornithorynchus, or duck bill, &c. Th squirrel, or flying cat, is found in Australia and some islands in the Indian Ocean. Bats of various species are met with in almost all the warm and temperate regions of the earth.

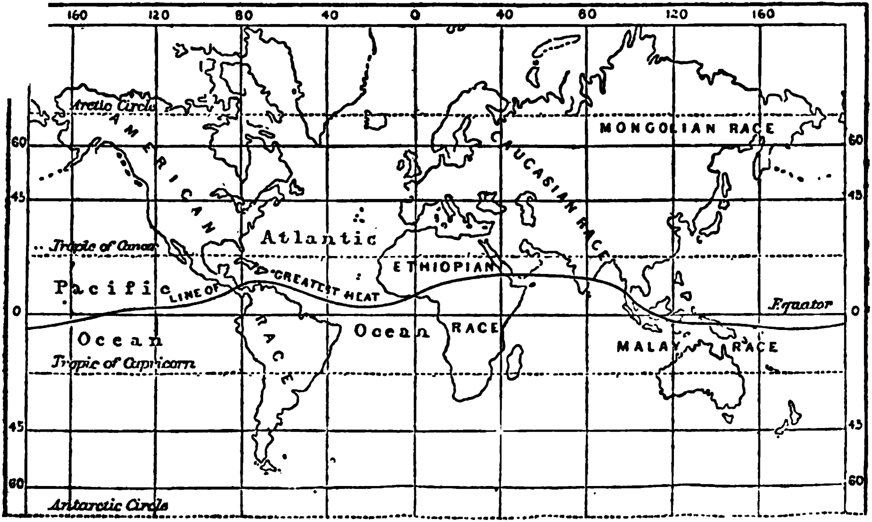
Birds, like other animals, have their natural geographical limits; and though some have a very wide range, others are confined to particular regions; thus, the birds of Paradise are found only in New Guinea, and some adjacent islands; the beautiful sun birds are confined to Africa, and the humming birds are peculiar to the New World. The powers of flight possessed by most birds, and the migratory instinct, which leads some species of birds to remove their quarters at the change of season, causes them to possess a very wide range, and to enjoy at all times a climate especially adapted to their wants.

In the animal, as well as in the vegetable kingdom, the largest number of species are met with in the warm regions of the globe, and a gradual decrease, in the number both of genera and species, takes place as we recede from the equator. It is in intertropical regions also, that mammiferous quadrupeds are most remarkable for their magnitude, strength, and ferocity; that reptiles are larger, and more venomous; that birds are decked with the most splendid plumage, and the insect tribes distinguished for their size and the brilliancy of their tints. These effects of light and heat, appear to be extended even to the inhabitants of the ocean; sharks and some other fish are larger and more ferocious in the seas of tropical regions, and some species of fish are adorned with gayer colours, than those of temperate zones. It is om the warm regions of the earth, that the number of the most beautiful shells of molluscous animals are obtained, and there likewise do the coral animals and other radiata, occur in the greatest variety and abundance.

Animals, like plants, are adapted for the stations or situations in which Creative Wisdom has placed them; and thus we find animals belonging to cold climates provided with warm furry coats, which would be unsuited for the inhabitants of hot regions. Sometimes when animals of the same species inhabit countries possessing different climates, the garb of the one will differ from that of the other, in accordance with the difference of climate. Thus, the skin of the stoat in England is comparatively thin, and of a dull greyish brown colour; but in northern Russia and Siberia, the coat of the animal is transformed into a beautiful thick fur, of a clear white in every part except the tip of the tail, which is of a deep black, affording, under this form, the well known fur called ermine.

If by accident, or the agency of man, animals are removed to places uncongenial to their natures, they either perish altogether, or some change takes place to fit them for their new abode. Thus, the race of sheep now inhabiting some of the valleys of inter-tropical South America, and which were originally transported from temperate European regions, possess, instead of their warm woolly fleeces, a coat of glossy hair, better adapted to the heat of the climate in which they have now become naturalized. Thus, again; a species of dormouse, which is a native of the warmer regions of the earth, does not in its natural habitation, where it can at all seasons of the year obtain abundance of food, become torpid, o

but if removed to this island, where



DISTRIBUTION OF MAN

subsistence fail during the winter, it acquires the habits of the English dormouse, and passes that season in a state of torpidity.

XIV. GEOGRAPHICAL DISTRIBUTION OF MAN.

THE geographical distribution of man forms a subject of totally different character from any that has hitherto engaged our attention. Instead of speaking of genera and species, we have now to direct our inquiries to the *diversities of language*, and the *varieties of form and colour*, in the human race, and to the distribution over the earth's surface of these diversities and varieties.

'The diversities of language,' according to Dr. Prichard, 'may be regarded as much more ancient than the varieties of form and colour in the human race.' Thus, though at the period which preceded the building of the Tower of Babel, we are expressly informed that 'the whole earth was of one language and of one speech,' we are also told, that evil men having vainly attempted to strive against their Maker, their language was 'confounded,' or in other terms, the language of one rendered unintelligible to another. Thus commenced the diversities of language in the human race.

The dispersion to which such an event would naturally give rise, each family separating from those whose language they could not understand, may be considered as having formed the first geo distribution of the human race, and may extent, be traced by the languages still in use on the surface of the globe.

The number of languages at present spoken in the world, is estimated at not much less than 2000; but many of these appear to be derived from one common root or origin. Thus, the Hebrew, the Babylonian, Syrian, Arabian, and Abyssinian, are considered to have one common origin. They are collectively called *Semitic*, from Shem, the son of Noah, from whom the nations speaking these languages are supposed to have descended. This is called a *family of languages.*

Another family of languages, which is called the *Indo-European*, includes a large number of the languages or *idioms* of Europe and Asia. 1. The *Sanscrit*, and all its dialects in India. 2. The ancient *Zend*, or *Medo-Persic* language, and all the idioms now spoken in Persia and Armenia. 3. The *Greek* and *Latin* languages. 4. The *Sclavonian.* 5. The *Teutonic.* 6. The *Celtic.*

The languages of some nations, though not so distinctly traceable to the same origin, are often found to bear a great resemblance to each other, and they are then considered to belong to the same *school* or *class* of languages. Such are those termed *mono-syllabic*, from their consisting of words of one syllable. To this class belong the languages of China, Tibet, Siam, and nearly all the Indo-Chinese countries.

Another class of languages are those termed *poly-synthetic.* These consist of long words of many ables, and very elaborate in their construction. is remarkable class of languages, belong all the numerous dialects or idioms of both North and South America.

A dispersion and separation into families and tribes having taken place at so early a period of man's history, considerable differences in the features and the colour of the skin, appear before long to have become hereditary in certain tribes or nations, probably occupying comparatively remote regions of the earth. These peculiarities having formed permanent distinctions, naturalists have attempted to class the human species into certain *races* or *varieties*, according to the colour of the skin, and the form of the skull.

The three leading divisions are the *Caucasian*, the *Mongolian*, and the *Ethiopian* races; to which may be added, the *Malayan* and the *American* races.

The *Caucasian*, or *White race*, is characterized by a fair skin, sometimes with colour in the cheeks, an oval face and expanded forehead, eyes varying from blue to dark brown; nose thin, and slightly aquiline or straight, small mouth, and a full and rounded chin; soft hair, varying in colour from black to light brown and flaxen, waving, or slightly curled.

The most refined and civilized, as well as most powerful nations of the earth, have belonged to the Caucasian race; and it is in the regions inhabited by this race, that both the Semitic and Indo-European languages have prevailed, and do still prevail. The ancient and modern inhabitants of the regions bordering on Mount Caucasus, the higher castes of India, the Affghans, the Medes, Persians, and Arabs, the inhabitants of Northern Africa, and the Jewish people, all belong to this race.

In Europe, the Caucasian race includes the ancient Greeks and Romans, and the present inhabitants of Greece, Italy, France, and other nations which derive their language and descent from the Greeks and Romans; the Sclavonians, who occupy Russia, Poland, and parts of Austria and Turkey; the Teutonic or Gothic tribes, who occupy Norway and Sweden, Denmark, Holland, Germany, Prussia, parts of Belgium, Austria and Switzerland, and a large portion of the British Isles: and the Celtic race, who inhabit the north western districts of Scotland, the west of Ireland, Wales, and some parts of Cornwall. This race, intermixed with the descendants of the ancient Romans, is also spread over Belgium, France, Switzerland, Italy, Spain, and Portugal.

We thus find that the Caucasian race inhabits the whole of Europe, with the exception of Lapland, Finland, and part of Hungary; a large portion of the south western regions of Asia; the northern part of Africa, from about N. lat. 20 to the borders of the Mediterranean Sea; and through European colonists, a considerable portion of America and of various other regions of the globe.

The *Mongolian* race is characterized by a yellowish or olive-coloured skin, a broad and flattened face, with a low and narrow forehead; small black eyes, obliquely set, a wide mouth and thick lips; black hair, lank and thin. The Mongolian race at the present day occupies a large portion of Asia, to the north and east of the Himalaya Mountains. The nomadic or wandering Mongolian and Kalmuc tribes all to this race; as do also the Chinese, noieds, and the inhabitants of Kamtchatka.

This race also occupies Finland, Lapland and Greenland, and part of Hungary, though in the latter territory, the characteristic features of the Mongolian race are much less strongly marked.

The *Ethiopian* or *Negro* race is characterized by a black or very dark skin; a narrow compressed skull, a low and narrow forehead, black eyes, a flat broad nose; thick lips, especially the upper lip; a small chin; woolly crisp coarse hair, collected into little knots. This race is considered to occupy nearly the whole of Africa to the south of the Great Desert; parts of Madagascar, Australia, and New Guinea, and some of the islands included in the Indian and Polynesian groups.

The *Malay* or *Malayan* race bears much resemblance to the Mongolian, though in the Malayan race the colour of the skin is darker, and the face less broad. This race occupies the Malay Peninsula, and a large portion of the islands of the Indian Archipelago.

The *American* race is characterized by a reddish coloured skin; by a high and receding forehead, with generally regular features, and a rather prominent and frequently aquiline nose. This race, though fast diminishing from the face of the earth, includes the aboriginal inhabitants of the whole American continent. All the tribes occupying that vast range of country, speak dialects or languages allied to each other, and belonging to that singular class which is formed of long polysyllables. The number of different dialects in America
at no less than 1500.

The diversities of language on
globe, still, as in the first hour wh

was 'confounded,' tend to the disunion of man from his fellow man: and undoubtedly we must look to the spread of the Gospel, as the sole efficient means of restoring union among mankind, and of leading all the different members of the human race to feel that they belong to one great family, that they are all brethren, and children of one FATHER. It may be little that we individually can do to promote this grand object, but we may endeavour to perform our part. By the acquirement of foreign languages, we may be better enabled to meet every man as our brother; and by the exercise of kindly feelings, and the mutual interchange of good offices, not only amongst our kindred and our countrymen, but amongst strangers and foreigners from every part of the globe, we may be instrumental in promoting 'peace on earth, good-will towards men.'

EXERCISES FOR THE EXAMINATION OF PUPILS.

I. The Objects of Physical Geography. (p. 1.)

What is meant by Physical Geography?——Why is it called Physical or Natural Geography?——What advantages may result from its pursuit?

II. The Earth. (p. 2.)

To what group of bodies does the earth belong?

What is the form of the earth?——Mention three different modes by which the rotundity of the earth may be proved.

How is the earth or globe divided into two parts?——How are maps of the world frequently divided?

What is the circumference of the earth?——What is its diameter from east to west?——What from north to south?

Give some account of the earth's turning on its axis; or of its diurnal motion.——Also of its motion in its orbit.——How is the earth placed in its orbit? and what is the consequence of this position?——Relate some particulars about mid-summer and mid-winter.

III. Latitude and Longitude. (p. 6.)

How is the earth or globe divided for the convenience of measurement?——How is latitude marked? and how many degrees of latitude are there?——From whence is latitude reckoned?——What is meant by high and low latitudes?——How are degrees subdivided?——How many miles are there in a degree of latitude?——What is meant when it is said that places are on the same parallel of latitude?

How is the earth divided by circles running parallel with the equator?——Mention the zones into which these divide the earth; also the parallels of latitude to which they extend; and for what cause particular names have been given to these zones.

How is longitude determined? and from whence is it reckoned?——How many degrees of longitude are there?——Give some particulars about the number of miles contained in degr
tude; and their difference in different latitudes.——
length of a degree of longitude in the parallel of L
the meaning of the terms east and west longitu
places said to be on the same meridian?——Wh
we speak of the sun's being on the meridian?

IV. General Distribution of Land and Water. (p. 9.)

What is the estimated proportion of land to water on the surface of the globe?——What in the northern and southern hemispheres?

Under what general heads may the dry land be considered?——Give an account of the two great continents.——Why are they called the old and new continents?

Describe islands.——Mention the largest island on the earth's surface.——What regions are included under the appellation Oceanica?

How is the land arranged in the eastern, and in the western continents?——Mention the direction of the greatest extension of land in the two continents.

V. Variations of the Surface. (p. 13.)

Describe the variations of the earth's surface.——Mention the usual arrangement of mountains.

Give some account of mountain ranges.——What direction do they usually appear to take?

Give the names of the principal mountain ranges which extend across the old continent.——Give the names of the mountain ranges which extend from north to south in the new continent.

How are mountain ranges frequently disposed, in peninsulas and islands?

Give some particulars about the appearance and form of mountains, and about glaciers.——Describe mountain branches, and spurs.——What are detached or isolated mountains?——Where are the loftiest summits usually met with?——Give the heights of the principal mountains.

Describe table-lands, or plateaus.——Mention the most remarkable plateau or table-land in Europe.——Mention table-lands in Mexico, in the Andes, and in Asia.

Describe plains or lowlands.——Mention the most remarkable in Europe; in Asia; and in Africa.——Describe the lowlands of North and of South America; and mention by what names they are distinguished.

What are the various kinds of valleys?——Describe principal valleys; lateral or transverse valleys; and subordinate valleys.——Describe basin-shaped valleys.——Give the various terms applied to narrow valleys; and for what cause some of these terms been applied.

forms the standard by which all the undulations on the urface are measured?——Mention a tract of land below the he sea.

VI. Geology. (p. 24.)

What is Geology?——What is meant by the earth's crust?——Of what does the earth's crust consist?——Mention the various kinds of rocks.——State also the meaning of the term fossil; and give some particulars about the general diffusion of fossils in all parts of the earth's crust.

Describe earthy formations; also pebbles, gravel, shingles, and boulders.——What is conglomerate, or pudding-stone?——What is breccia?

Mention the most abundant earths.——In what mineral substance is silex found in a pure state?——In what form is lime usually met with?——What useful property does clay possess?

How are rocks classed?——What are stratified or sedimentary rocks?——How do they seem to have been formed?——How are stratified rocks arranged? and how is their relative age determined?

By what means are the lower rocks sometimes brought to the surface?——Give the meaning of the term 'crop out,' referring to the cut, p. 27.——Mention the advantages which may result from this.

What are unstratified rocks?——Mention the apparent mode of their formation; and name the principal rocks of this kind.

Into what three classes are unstratified rocks divided?——Describe plutonic rocks.——State under what circumstances they are supposed to have become consolidated.——Describe trap rocks.——Mention the principal rocks of this class.——Describe volcanic rocks.——Mention the principal products of active volcanos.

In what regions of the earth do the most remarkable active volcanos occur?——How may volcanic eruptions prove beneficial?——Give some account of a tremendous eruption in Iceland.——State the apparent connexion between earthquakes and volcanic eruptions.

What effects are sometimes produced by earthquakes?——Do earthquakes occur in regions remote from active volcanos?

Give some account of extinct volcanos.——Describe intrusive rocks; and metamorphic rocks.——Give an instance of a transformed rock.

What are dislocations or faults?——What benefit results from faults?——What do fissures sometimes contain?

Give some particulars about metallic veins.——Where is gold usually found?——Where are copper, tin, lead, silver, and iron usually found?

How are stratified rocks arranged?——Describe metamorphic rocks, and mention where they are met with.

Give the names of the four groups into w ed rocks are divided.——Describe the Silurian group of rocks.——Describe the Devonian group.——How is the carboniferous group subdivided?——Describe mountain limestone.——Give some particulars about the fossils of the coal measures.——Describe the coal measures; and mention the principal localities where they occur in the British Isles.——What are the most abundant fossils of the coal formation?——Describe the Permian group.

What five groups are included in the secondary stratified rocks?——Describe the Trias group.——In what formation is salt usually met with?——Describe the Lias group.——Describe the Oolite group.——Describe the Wealden group.——How is the cretaceous group subdivided?——Where are the four divisions of the cretaceous group well displayed?——Refer to the cut, p. 27.——Describe greensand and gault.——Describe the chalk formation.

What groups or periods do the Tertiary stratified rocks include?——Give some particulars about the Eocene group, or period; about the Miocene period; and about the Pliocene period.——Mention the deposits in which the mammoth has been found.——Describe the boulder formation; and its connexion with the glacial period.

Give an account of changes now in progress on the earth's surface.

VII. THE WATERS OF THE GLOBE. (p. 42.)

Under what heads may the waters of the globe be considered?

From whence do springs take their rise?——How are internal reservoirs supplied with water?——What does spring water contain? and what forms the distinction between soft water, hard water, and mineral waters?——Name the largest spring in Great Britain.

How may mineral springs be classed?——Describe acidulous springs.——Describe chalybeate springs.——Describe sulphureous springs.——Describe the two kinds of saline springs.——Describe calcareous springs; and give some account of their mineralizing or petrifying properties.——Describe stalactites and stalagmites.——Describe siliceous springs.

Are thermal or hot springs of frequent occurrence?——Describe the two kinds of hot springs.——Give some particulars about the temperature of the earth at various depths; and mention by what means this has been ascertained.——Which kind of spring has usually the highest temperature?——Name some remarkable hot
Describe bituminous springs.

do rivers derive their supplies of water?——What
term water-shed?——What constitutes the basin of
the area of the principal river-basins.

On what does the velocity of a river in great measure depend? ——Describe cataracts, cascades, and rapids.——Describe deltas; and estuaries.——What is meant by the bore?——Give some particulars about flood-seasons, or freshets.——What is the number of considerable rivers in the Old World?——What in the New?—— Give the length, situation, and termination of the principal rivers.

Give some *account* of the various kinds of lakes.——Describe *lakes at the sources* of springs; lakes in the course of a river; lakes in *depressions* of the earth; lakes in the craters of extinct volcanos; periodic lakes.——Mention the largest lake in England; the largest lakes in Europe; in Asia; in North America.

What advantages result from the great extent of the ocean? ——Does the ocean form one vast mass of waters?——Give its geographical divisions.——Describe branch or inland seas.—— Describe lochs, voes, and fiords.

Give some particulars about the depth of the ocean; about its temperature; about its saline contents.——Mention the usual degree of saltness of inland seas; and what sea forms an exception to the general rule.

What is the freezing point of sea-water?——Give some account of icebergs.

Does it appear that sea-water has any colour?——Is its colour sometimes influenced by its bed?——Also by the presence of minute animals?——What causes the luminous appearance of the ocean?

VIII. Tides, Waves, and Currents. (p. 60.)

What causes the perpetual movement of the waters of the ocean? ——By what attraction are the waters retained in their bed on the earth's surface?——By what attraction is the great primary or tidal wave formed?——How is ebb-tide or low water on our shores produced?——How is flood-tide or high water produced?——What are spring tides?——State the course of the Atlantic tidal wave;— and the difference between high and low water at various places.

Describe secondary or wind waves.——Describe the ground sea.

What causes the currents of the ocean?——And which are the most remarkable currents?——Describe the Polar currents.—Also the equatorial currents.——And the great system of currents commencing in the Antarctic Seas.——Describe the Gulf stream.

IX. The Atmosphere. (p. 64.)

Describe the earth's atmosphere; and mention its hei
Of what is atmospheric air composed?——Give some
the elasticity and the density of air.——Mention th

to which this gives rise.——State what is meant by the term 'weight of an atmosphere;' and give some particulars about the barometer.

What effects are produced in the temperature of the air by height above the sea-level?

What appears to give rise to winds?——Give some particulars about winds.——Give an account of the trade-winds.——What causes south-westerly and north-westerly winds to prevail in higher latitudes?——Give a description of the monsoons?——What causes sea-breezes?—and land-breezes?

What are hurricanes?—and what are typhons and ox-eyes?——How do tornadoes, pamperas, and arched squalls differ from hurricanes?

Describe the sirocco, solano, simun or simoon, and also the harmattan.

In what state is water always present in the atmosphere?—and by what means does it find its way there?——How is dew formed?—and when is it most abundantly deposited?——On what substance is dew usually most copiously deposited?

When are mists and fogs likely to be formed?

How are clouds formed?—and of what do they consist?——Mention also how rain is formed, and under what circumstances hail and snow are formed.

What names are given to the principal forms of clouds?——Describe the four principal kinds of clouds.——At what height in the atmosphere is the zone of clouds?—and which are the highest, and which the lowest clouds?——Mention the names of the combinations of the principal kinds of clouds.

In what parts of the earth does the largest quantity of rain fall?——Is it more abundant in the New than in the Old World?——Mention the rainless districts of the earth.——State the cause of the difference in the amount of rain in different regions.——What difference is there in the quantity of rain in the eastern and western parts of the British Isles?

Give some particulars about rainy and dry seasons; and also relative to the belt or zone called the 'variables.'——Give an account of the fall of rain in intertropical countries, and in countries beyond the tropics.

X. CLIMATE. (p. 80.)

t is meant by the term CLIMATE?——What are the most
nt causes of diversity of climate?
is the grand agent in diffusing heat over the earth's sur-
Mention the effects produced by the earth's diurnal rota-

tion; and also the beneficial results from its inclined position in its orbit.

How far does the artificial division of the earth into torrid, frigid, and temperate zones, correspond with the climates of those regions?

Mention another leading cause of the diversity of climate?——What is signified when we speak of an insular climate?——What by an excessive climate?——Mention an instance of the effects produced by a large surface of water in tempering or moderating the climate of some regions of the earth.

Mention another leading cause of the diversity of climate; and give an account of the height of the snow-line in different regions. ——Refer to the tabular view for its height in various latitudes. ——What appears to be the cause of its greater height at certain distances from the equator, than under that line?——Mention the beneficial results arising from the different temperature at different heights.——Describe the effects produced on vegetation by elevation above the sea-level, in the hot regions of the earth.

Give some account of the temperature of mountains near table-lands.——Mention the Himalaya Mountains as an example; and state some particulars about isolated mountains in different climates.

What effects are produced on climate by the nature of the soil? ——What by the prevailing winds?——How do mountain ranges affect climate?——What effects are produced by the currents of the ocean?——Give some account of the sea of Sargasso; and mention the effects it produces on the temperature of the Northern Ocean.

What districts usually possess more excessive climates?——Does the temperature vary as much in intertropical, as in temperate regions?

What are isothermal lines?——Do they run parallel with the equator?——What are isotheral and isochimenal lines?——What is the average degree of heat of the line of highest temperature? ——What regions does it cross?——Which is considered to form the hottest region of the earth?

XI. Electricity and Magnetism. (p. 92.)

Does Electricity act any part in the natural world?——Mention what is meant by ordinary electricity, and how may it be called forth?—and what is meant by voltaic electricity?

What is meant when it is said that any substance is positively electrified?—and what when negatively electrified?——Give some particulars about the electricial state of substances, effects produced if they come in contact.

In what state of electricity is the earth consider and in what pure atmospheric air?——Mention, also, by what means the electrical equilibrium of the air is liable to be disturbed, and how it is sometimes restored.——At what periods of the day and of the year is electrical intensity greatest?

What effects does it appear that voltaic electricity is continually producing in the earth's crust?—and what substances are supposed to be formed by its powerful agency?

What is terrestrial magnetism?——Under what heads may it be considered?——How may the magnetic, or attractive power of the loadstone be imparted to iron or steel, or how may it become magnetized?——What is meant by the magnetic direction of the compass needle?——In what direction does the needle point?——Is this direction subject to vary, and what is its variation termed?——What is meant by lines of eastward and westward variation?——What by lines of no variation?

What is meant when we speak of the dip or inclination of the magnetic needle?——Describe the magnetic equator, and mention its position.

By what means is magnetic intensity ascertained?—and in what parts of the globe is it supposed to be greatest?

XII. GEOGRAPHICAL DISTRIBUTION OF PLANTS. (p. 96.)

Give some particulars about the plants on the earth's surface?——Mention the adaptation of plants to all parts of the earth.

Into what classes are plants naturally divided?

Describe cryptogamic, or a-cotyledonous plants.——Describe endogenous, or mono-cotyledonous plants.——Describe exogenous, or dicotyledonous plants.

Which class of plants includes the greatest number of species?——What is the proportion of the different classes in different zones?

Describe perennial plants; annual; and biennial plants.——Describe deciduous plants; and mention in what parts of the earth they most abound.——Give an account of the peculiar character of the evergreen trees of hot regions, and that of those of cold regions.

From whence do plants derive their nourishment?——What effects are produced on plants by light?——Give some particulars about the composition of plants, and what is required to bring them to perfection.

In what regions of the earth are the vegetable productions most varied?——State the relative proportion in the different zones.

same plants met with in all regions possessing similar
—How is the earth divided into botanical regions?
account of the correspondence between the plants of

Arctic regions, and those of high mountains in hot climates; also of the resemblance between those of temperate regions, and of the middle region of such mountains.——Give Baron Humboldt's division of the earth into eight zones.——Give the scale of vegetation at various heights in temperate Europe.

On what account is it important to be acquainted with the zones and climates in which plants will succeed?——Mention the highest northern limit of the successful cultivation of wheat, oats, and barley, in Europe.——State how gratifying the pursuit of this science is likely to prove.

XIII. Geographical Distribution of Animals. (p. 106.)

Does it appear that the distribution of animals on the earth's surface is influenced by climate?

Mention the four great divisions of the animal kingdom.

Why are vertebrated animals so named, and what is their peculiar characteristic? and what animals are included in this division? ——Into what four classes are vertebrated animals subdivided?

Why are molluscous animals so named, and what animals belong to this division?——Why are articulated so named, and what animals are included in this division?——State, also, what animals are called crustaceous.——Why are radiated animals so named, and what animals belong to this division of the animal kingdom?

Which of these four divisions ranks as the lowest among living creatures?—and which as the highest?——Which forms the highest class among vertebrated animals?

Give the meaning of the several terms species, genus, order, and class; and give the example.

Do we find that certain species of animals are peculiar to particular regions?——Mention some of the animals peculiar to the Old World.——Mention some animals peculiar to the New World.—— What animals are met with in the more northerly regions of both continents?——Mention the peculiarity of the group of animals inhabiting Australia.

Give some account of the geographical distribution of birds.

Are the animals inhabiting warm regions usually more conspicuous than those of temperate regions?

Give some account of the adaptation of animals to the regions which form their natural habitations; and give instances of the changes which sometimes take place when animals are removed to other climates.

XIV. Geographical Distribution of Man. (p. 113.)

What is considered to have formed the most ancient division among mankind?——Give some account of what appears to have led to the first dispersion of the human race.

How many languages or dialects are now spoken in the World?——What are languages called, which appear to be derived from the same root or origin?——Why is one family of languages called 'Semitic?'——Give an account of the Indo-European family of languages.

What are schools of languages, or classes of languages?——What languages are included in the mono-syllabic class?——What languages are included under the class called poly-synthetic?

To what consequences did the dispersion of mankind apparently lead?——Mention the leading divisions or varieties of the human race.

What are the characteristics of the Caucasian race?——What regions have they occupied, and at present still occupy?——What are the characteristics of the Mongolian race, and what regions do they occupy?——What are the characteristics of the Ethiopian or Negro race, and what regions do they occupy?——What are the characteristics of the Malay or Malayan race, and what regions do they occupy?——What are the characteristics of the American race, and what portion of the globe do they occupy?

What has tended to disunite mankind, and what may tend to restore union among the human race?

THE END.

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